

Public Health Assessment

Phoenix Goodyear Airport (North) Superfund Site

Goodyear, Maricopa County, Arizona

CERCLIS #AZD980695902



Prepared by

**Office of Environmental Health
Environmental Health Consultation Services**

Under Cooperative Agreement with the Agency for Toxic Substances and Disease Registry (ATSDR)

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LIST OF ACRONYMS AND ABBREVIATIONS

ADHS	Arizona Department of Health Services
ADEQ	Arizona Department of Environmental Quality
ALAA	American Lung Association of Arizona
ACS	American Cancer Society
ATSDR	Agency for Toxic Substances and Disease Registry
CDD	polychlorinated dibenzo-p-dioxins
CDF	polychlorinated dibenzofurans
COC	chemical of concern
HBGL	Health-based Guidance Levels
IMSAMET	name of the aluminum smelter in the Goodyear area
LIPSCO	Litchfield Water Company
MAG	Maricopa County Association of Governments
MCL	maximum contaminant level
MEK	methly ethyl ketone
mg/m ³	milligrams per cubic meter
m/sec	meter per second
MRL	minimal risk level
NA	not applicable
ND	not-detected
NRC	National Research Council
NS	not sampled
OAC	outdoor air concentrations
OSHA	Occupational Safety and Health Administration
PCBs	polychlorinated biphenyls
PCP	pentachlorophenol
PGA	Phoenix Goodyear Airport
PM-10	particulate matter
ppb	parts per billion
ppm	parts per million
RID	Roosevelt Irrigation District
SLE	Systemic Lupus Erythematosus
SRLs	Soil Remediation Levels
TCA	trichloroacetic acid
TCDD	dioxin (tetrachlorodibenzo-p-dioxin)
TCE	trichloroethylene
TSH	thyroid-stimulating Hormone
USEPA	United States Environmental Protection Agency
VOCs	volatile organic compounds
µg/L	micrograms per liter

GLOSSARY

<i>aquifer</i>	a permeable rock stratum below the earth's surface through which groundwater moves; generally capable of producing water for a well.
<i>chemicals of concern</i>	chemicals whose concentrations are above the appropriate screening level.
<i>clean</i>	this word is used to describe water quality. This indicates that the water quality in question is in compliance with federal water quality standards developed by the United States Environmental Protection Agency.
<i>detection limit</i>	the minimum concentrations that must be accurately and precisely measured by the laboratory and/or specified in the quality assurance plan.
<i>dose</i>	the amount of contamination absorbed or deposited in the body of an exposed organism for an increment of time. A total dose is the sum of doses received by a person from a contaminant in a given interval resulting from interaction with all environmental media that contain the contaminant. Units of dose and total dose are often converted to units of mass per volume of physiological fluid or mass of tissue.
<i>exposure</i>	an event that occurs when there is contact at a boundary between a human being and the environment with a contaminant for a specific concentration for an interval of time: the units of exposure are concentration multiplied by time.
<i>exposure pathway</i>	the process by which an individual is exposed to contaminants that originate from some source of contamination and are categorized as inhalation, dermal, and/or ingestion exposures.
<i>gene mutation</i>	a persistent change in a single gene.
<i>latency</i>	the period between stimulus application and response onset.
<i>maximum contaminant levels</i>	enforceable drinking water standards that are protective of public health to the extent feasible with current technology.
<i>minimal risk level</i>	an estimate of daily exposure of a human being to a chemical (in mg/kg/day) that is likely to be without an appreciable risk of adverse noncancerous effects over a specified duration of exposure.

<i>particulate</i>	small, discrete, solid or liquid bodies, especially those suspended in a liquid or gaseous medium.
<i>parts per million</i>	one part per million (ppm) equals 1 pound chemical per million pounds of water.
<i>public health assessment</i>	an evaluation of relevant environmental data, health outcome data, and community concerns associated with a site where hazardous substances have been released.
<i>quality assurance</i>	a planned system of activities whose purpose is to provide assurance of the reliability and defensibility of the data.
<i>quality control</i>	a routine application of procedures for controlling the monitoring process. QC is the responsibility of all those performing hands-on operations in the field and in the laboratory.
<i>route of exposure</i>	means by which the contaminant actually enters or contacts the body, such as ingestion, inhalation, dermal contact, and dermal absorption.
<i>soil remediation levels (SRLs)</i>	health-based soil screening levels. SRLs protect against toxic doses of systemic toxicants and limit excess lifetime cancer risk to one-in-one-million.
<i>volatile compounds</i>	compounds amenable to analysis by the purge and trap techniques, also referred to as purgable compounds.
<i>volatilization</i>	the conversion of a liquid or solid into vapors.

Foreword

The Agency for Toxic Substances and Disease Registry (ATSDR), was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the Superfund law. This law set up a fund to identify and clean up our country's hazardous waste sites. The United States Environmental Protection Agency (USEPA) and the individual states regulate the investigation and clean up of the sites under this law.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the sites on the USEPA National Priorities List. These evaluations are to find out if people are being exposed to hazardous substances and if so, whether that exposure is harmful and should be stopped or reduced. If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental and health scientists from ATSDR and from states with which ATSDR has cooperative agreements. The Arizona Department of Health Services (ADHS) has a cooperative agreement with ATSDR to conduct public health assessments.

Exposure: As the first step in the evaluation process, ADHS and ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data, but reviews information provided by USEPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data are needed.

Health Effects: If the review of the environmental data shows that people have or could have come into contact with hazardous substances, ADHS and ATSDR scientists evaluate whether or not these contacts may result in harmful effects. ATSDR and ADHS recognize that children, because of their play activities and their growing bodies, may be more vulnerable to these effects. As a policy, unless data are available to suggest otherwise, ATSDR and ADHS consider children to be more sensitive and vulnerable to hazardous substances. Thus, the health impact to the children is considered first when evaluating the health threat to a community. The health impacts to other high risk groups within the community (such as the elderly, chronically ill, and people engaging in high risk practices) also receive special attention during the evaluation.

ATSDR and ADHS use scientific information, which can include the results of medical studies, toxicological studies, epidemiologic studies, and disease registries to help determine the health effects that may result from exposures. The science of environmental health is still developing, and sometimes scientific information on the health effects of certain substances is not available. When this is the case, the report will suggest what further public health actions are needed.

Conclusions: The report presents conclusions about the public health threat, if any, posed by a site. When health threats have been determined for high risk groups (such as children, elderly,

chronically ill, and people engaging in high risk activities), they will be summarized in the conclusion. Ways to stop or reduce exposure will then be recommended in the public health action plan.

ATSDR and ADHS are primarily public health advisory agencies. These reports identify what actions are appropriate to be undertaken by environmental agencies, or other responsible parties, to protect public health. However, if there is an urgent public health threat, ATSDR and ADHS can issue a public health advisory warning people of the danger. ATSDR and ADHS can also initiate public health education activities or pilot studies of health effects, full scale epidemiology investigations, disease registries, surveillance studies or research on specific hazardous substances.

Interactive Process: The public health assessment is an interactive process. ATSDR and ADHS solicit and evaluate information from numerous city, state, and federal agencies, the companies responsible for clean up, and the community. Conclusions are then shared with these stakeholders. Agencies may also be asked to respond to an early version of the report to make sure that the data they have provided is accurate and current.

Community: ATSDR and ADHS also need to learn what people in the area know about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR and ADHS actively gather information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals, and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for inclusion of their comments. All the comments received from the public are addressed in the final version of the report.

Comments: If after reading this report, you have questions or comments, we encourage you to send them to us.

Letters should be addressed as follows:

Attention: Chief, Office of Environmental Health
Arizona Department of Health Services
3815 N. Black Canyon Highway
Phoenix, AZ 85015

Summary

The Arizona Department of Health Services (ADHS) prepared this Public Health Assessment (PHA) to evaluate whether a public health hazard exists as a result of potential environmental exposures from the contamination at the Phoenix Goodyear Airport (PGA) North site. Another objective of this report was to investigate and address the health concerns of the residents in the Goodyear area, including former Unidynamics workers.

This report uses available environmental data from the site and information collected from members of the community regarding their health concerns. There were 81 exposure histories taken of which 31 people were former Unidynamics employees, and the remaining 50 were community residents who lived or had lived in the area at some time since 1960. There were many concerns, including health concerns, of residents and former Unidynamics workers that were related to living near the PGA North site or previous employment at the former Unidynamics facility. These community concerns are identified and addressed in the public health assessment.

This public health assessment found the following:

- Public drinking water supply wells in the area are clean and present no public health hazard.
- Globe Wells # 1 and #2 are private wells that provide water to small irrigation canals used to irrigate agricultural fields on the northern portion of the PGA North site. The water from these wells flows into a holding pond area which is also connected to the small irrigation canals. These wells were found to contain levels of trichloroethylene (TCE) above USEPA's maximum contaminant level (MCL) of 5 micrograms per liter (µg/L). However, toxicological evaluation shows the level of TCE is one that would not be expected to cause adverse health effects for residents either through inhalation, ingestion, or dermal exposures.
- Globe Well #2 was also found to have traces of perchlorate. However, the level of perchlorate was not above ADHS's health-based guidance level (HBGL) and would not be expected to cause adverse health effects if children play or drink the water or if farmworkers use it to cool themselves off or drink during the hot summer days. Exposure to the water in the small irrigation canals on the northern portion of the PGA North site would not be expected to cause adverse health effects and is classified as no apparent public health hazard.
- There are many physical hazards along the small irrigation canals connected to the Globe Wells and the holding pond area on the northern portion of the PGA North site that present a public safety hazard. These include rusted broken metal and cement pipes that children can crawl into, a large unprotected open well which a child could fall into, rusty piping around the Globe wells, rusted metal laying on the ground, dangerous electrical

outlets, and other physical hazards that could hurt children who play in the area. When the water is not flowing through the canals, the underlying tunnels are left open and leave an area where children could fall into and get hurt. Since new housing developments are being built in the nearby area bringing in new residents, the condition of the Globe wells and small irrigation canals will also present a public safety hazard to children in the future.

- The water from the SunCor Well 33-A, which has a carbon filter treatment system, is being used for irrigation of the golf courses and ornamental lakes in the Pebble Creek housing development and the new SunCor housing development. As long as the carbon filter treatment system for SunCor Well 33-A is maintained and monitored, the water used for irrigation purposes and ornamental lakes is safe and presents no apparent health hazard.
- There are two private wells at the Park Shadows Apartments. The level of TCE in the irrigation well is below USEPA's MCL of 5 µg/L and poses no apparent public health hazard. TCE has not been detected in the drinking water well.
- A community survey revealed that many residents in the Goodyear area are concerned about living near the Unidynamics facility (part of the PGA North site).
- The on-site soil contamination presents no public health hazard because the site is fenced. The on-site thermal oxidizer has been turned off, which eliminates any related present air pollution issues. There are not enough data to determine if or how much dioxin was in the thermal oxidizer emissions when it was operating. However, the levels of TCE in the past air emissions of the thermal oxidizer were below ambient air screening levels and posed no apparent public health hazard.
- Former Unidynamics workers have voiced major concerns about their health problems that have developed subsequently to their employment at the plant. Some of the health problems expressed by former workers, such as respiratory, heart, nerve, and eye problems, appear to be consistent with long term exposure to working with high levels of TCE. As with any occupational exposure to hazardous chemicals over time, the possibility exists that some of the health conditions of former workers may have been caused by their exposures to the chemicals that were used at the Unidynamics plant. However, ADHS is not able to directly link the cause of these health problems to past exposures to chemicals at the plant because many confounding factors are involved. ADHS found historic occupational exposure to chemicals at the Unidynamics plant to be an indeterminate health hazard to workers.
- The most common health complaints expressed by both the community residents and former workers were respiratory problems including asthma. Respiratory problems in former workers, among other health problems, are consistent with occupational studies conducted analyzing long term exposure to TCE. These types of symptoms for

community residents are also consistent with living in a very active agricultural and farming area such as Goodyear. Almost any farming activity causes dust, particulate matter, and pesticides to get into the air which can cause breathing problems for community residents who live nearby.

- Many community residents are concerned about the emissions from the IMSAMET facility, an aluminum recycling plant near the southwest corner of the Goodyear Airport. This facility is not connected to the PGA Superfund Site. However, ADHS investigated complaints about facility emissions in response to community concerns during the PGA North site survey. The type of industrial process conducted at IMSAMET will release smoke, odor, and particulates (small particles) into the air. Since 1995, Level II source testing, conducted by IMSAMET, for criteria pollutants have indicated that the facility is in compliance according to the permit conditions listed by Maricopa County with the exception of a test conducted in 1999. The 1999 test, conducted by Maricopa County, showed elevated levels of carbon monoxide. The results are being verified. Even though the levels of particulates in the emissions are within acceptable limits, the inhalation of particulates may cause respiratory irritation, aggravate mucous membranes, and create discomfort in those people already prone to respiratory problems.
- ADHS staff have conducted three epidemiological studies that reviewed mortality and incidence data in Maricopa County including the Goodyear area. The data from these studies indicated that there were not elevated mortality or incidence rates of total cancers or leukemia in the Goodyear area between 1965 and 1990.

*ADHS concludes that **no apparent public health hazard** exists as a result of ingestion, dermal, or inhalation exposures by residents to the contaminated groundwater at the PGA North site given the current data. Physical hazards are present around the small irrigation canals and the Globe wells located on the north end of the PGA North site contaminated groundwater plume. These physical hazards present a **public safety hazard** to children. Historic occupational exposure to chemicals at the Unidynamics plant have posed an **indeterminate health hazard** to workers.*

1.0 Background

1.1 Site Description and History

The Phoenix Goodyear Airport (PGA) Superfund site is located in Goodyear, Maricopa County, Arizona, approximately 17 miles west of downtown Phoenix. The site is divided into two separate project areas, PGA North and PGA South. This public health assessment evaluates whether a public health threat exists at the PGA North site. The PGA North site consists of the former Unidynamics facility located on Litchfield Road. There is a contaminated groundwater plume that extends approximately 2 miles northward from the facility. The physical boundaries of the PGA North site are Thomas Road to the north, Litchfield Road to the east, Yuma Road to the south, and near Bullard Road to the west. Figure A1 in the Appendix shows the location of the PGA North site.

Unidynamics began operation in 1963 as a research development and manufacturing plant producing ordinance and electromechanical defense systems in defense and aerospace applications. As a defense contractor, Unidynamics was responsible for the design, development, production, testing, and support of tactical and strategic weapon and defense systems. A variety of chemicals such as nitric acid, hydrochloric acid, tear gas, explosive powders, paints, glues, oils, acetone, and radioactive materials were used in this industry. Workers were involved in machining, welding, mechanical and electrical assembly in making defense items such as missile heads, hand grenades, initiators, detonators, tear gas, and other products for defense purposes.

From 1963 to 1974, waste was generated and disposed of on the Unidynamics property. In 1981, ADHS discovered that groundwater in the PGA area was contaminated with solvents and metals. As a result, the United States Environmental Protection Agency (USEPA) added the PGA site to the National Priorities List (NPL) in September 1983. In 1984, USEPA began a remedial investigation of the Goodyear Airport area to characterize the site, discover the extent of the contamination, and identify possible sources. The Crane Company (Crane Co.) bought the Unidynamics business and property in 1985. In the early 1990's, Crane Co. sold the Unidynamics business to Pacific Scientific Energy Dynamics located in Chandler, Arizona where several former Unidynamics workers are presently employed. Crane Co. continues to own the former Unidynamics property and is responsible for the clean up activities at the site.

The contaminants identified at the PGA North site are chlorinated solvents (mainly trichloroethylene (TCE), acetone, methyl ethyl ketone (MEK) and perchlorates (the primary oxidizer in solid rocket fuel, explosives, and pyrotechnics). TCE and perchlorate are present in the soils located on the Unidynamics property as well as in the groundwater. Radioactive sources were removed in 1980 and 1984. In September 1990, USEPA issued an Administrative Order directing the Crane Co. to conduct soil and groundwater remediation for the PGA North site in accordance with USEPA's 1989 Record of Decision (ROD) for the PGA Superfund site. In response to the Administrative Order, Crane Co. began groundwater monitoring, groundwater cleanup, and soil cleanup programs which still continue.

1.2 Site Visit

Site visits were conducted by ADHS staff on several occasions during the summer of 1999. The groundwater plume, which extends north of the Unidynamics facility, underlies agricultural fields near Bullard Road, one farm, new housing developments with golf courses, and some construction areas. However, the land over the groundwater plume is not considered part of the Superfund site since it is not contaminated. Figure 2 in the Appendix shows the location of the Unidynamics facility and the groundwater plume. Photographs of the PGA North site are included in the Appendix. The following observations were made:

1. The PGA North site consists of the former Unidynamics facility, and the related groundwater contamination that extends approximately 2 miles northward of the Unidynamics facility. Above the groundwater plume are alfalfa fields, one farm, new housing developments, the Roosevelt Irrigation District (RID) Canal, and some construction areas.
2. The Unidynamics property is completely surrounded by a chain-link fence preventing public access.
3. There is an air-stripper system on the southwest corner of the Unidynamics property. Access is restricted by a fence surrounding the unit.
4. A thermal oxidizer, which has been shut down by USEPA, is located on the Unidynamics property. The unit is surrounded by a fence.
5. The Pebble Creek housing development is located north of the large Roosevelt Irrigation District (RID) canal. The new SunCor housing development, which is currently under construction, will be located south of the RID canal and east of Bullard Road. This development will include ornamental lakes and a golf course over the area where the groundwater plume is located.
6. The Globe wells are located south of the RID canal and west of Bullard Road. They provide irrigation water to the nearby agricultural fields located to the west of Bullard Road through a series of small irrigation canals that border the fields. Trichloroethylene (TCE) has been detected in these wells. The water from the small irrigation canals appears to flow into a large holding pond area that also borders the RID canal. There is trash along the edges of these water holding areas indicating that children may play in this area.
7. There are many physical hazards along the smaller irrigation canals and the holding pond area. These include rusty broken metal pipes, large broken cement pipes that children can crawl into, a large unprotected open well which a child could fall into, rusty piping around the Globe wells, and rusted metal objects on the ground.

8. The Park Shadows Apartments are located approximately one-half mile south of the Unidynamics facility. It encompasses 44 acres and has one private irrigation well and one private drinking water well. There are several playgrounds located throughout the apartment complex.
9. The Phoenix-Goodyear Airport (PGA South) is located south of Yuma Road and the PGA North site.
10. The IMSAMET Aluminum Plant is located near the southwest corner of the Phoenix-Goodyear Airport, approximately one mile southwest of PGA North site, but is not part of the PGA Superfund site. The facility recycles aluminum and is characterized by large piles of aluminum dross.

1.3 Demographics

Census data indicate that in 1990 approximately 5,200 persons lived in the Goodyear area. This has tripled to approximately 15,500 in 1999. New housing developments and shopping centers continue to be built throughout the area bringing more people to the west valley area of Phoenix.

1.4 Land Use and Natural Resources

The Goodyear area is a very active agricultural and farming community located 17 miles west of Phoenix. At one time, Goodyear, Inc. grew cotton throughout the west valley area for military use, mainly to be used in tires for aircraft and other military equipment. The former Unidynamics plant began producing materials for the Department of Defense in 1963 contaminating both soil and groundwater in the area. The facility closed in 1990 (Malcolm Pirnie, 1999b).

Remediation activities are being conducted throughout the PGA North site. A large agricultural property is located just east of Bullard Road and north of McDowell directly over the groundwater plume. It has been sold to SunCor, Inc. and is currently being built into a housing division with golf courses and ornamental lakes.

The water table under the PGA North site is situated 100 and 130 feet below the land surface. The subsurface consists of alluvial material (silty sands and gravel with intermittent clay lenses) that is subdivided in hydrogeological units based on hydraulic properties. Groundwater in the upper hydrogeologic unit flows toward the north-northwest. Vertical gradients of the groundwater are downward due to regional pumping of groundwater for irrigation and water supply and due to infiltration recharge to the groundwater environment (S.S. Papadopoulos & Associates 1998).

1.5 Health Outcome Data

ADHS has conducted three epidemiological studies that review mortality and incidence data in

Maricopa County, including the Goodyear area. The first two epidemiological studies provide and analyze both mortality and incidence health data for a twenty-year time span from 1965 to 1986 for Maricopa County. The follow-up incidence study provides mortality data from 1987 to 1990. The data provided in these studies indicate that there have not been elevated mortality or incidence rates of total cancers or leukemia in the Goodyear area between 1965 and 1990. The results of these studies are provided below.

1.5.1 Mortality and Incidence Studies for Maricopa County

Report on Mortality in Maricopa County: 1966 to 1986

Age-specific total cancer and leukemia mortality rates were not statistically elevated in the Goodyear area during 1966 to 1986 when compared to the national rates of the United States. Cardiovascular diseases were elevated for 45 to 64 year olds only for the time period from 1982 to 1986. Deaths from injuries were statistically elevated in the Goodyear area during the entire time period from 1966 to 1986 in various age groups.

Incidence Study of Childhood Cancer in Maricopa County: 1965 to 1986

The ADHS conducted this study to measure the incidence rates of childhood leukemia and all cancers during the period 1965 to 1986 among the zero to 19-year-old resident population of Maricopa County. There was no statistically elevated incidence of total cancers or leukemia in the Goodyear area when compared to the remaining areas in Maricopa County. There also was no statistically elevated incidence of total cancers or leukemia for ages zero to 19 years in the Goodyear area when compared to the same age group nationwide during 1965 to 1986.

Follow-up of Childhood Leukemia Incidence Rates in Maricopa County: 1987 to 1990

This study was conducted in 1993 as a follow-up study to the previous incidence study. There were no reports of childhood leukemia during the years of 1987 to 1990 in the Goodyear area.

In summary, the Goodyear area did not have elevated rates of cancer, and childhood leukemia during the years 1965 to 1990. These studies have limitations which are described in the Health Outcome Data Evaluation Section, 5.2.

2.0 Community Concerns

The overall mission of ADHS and ATSDR is to address the public health concerns of the residents who live near hazardous waste sites, such as the PGA North site. This public health assessment documents the community concerns of the residents living near the PGA North site. Identifying and addressing the concerns of the community near a Superfund site is crucial if the public health assessment is to satisfy its purpose of helping the public and health professionals understand the health risks posed by a site. This section describes the various concerns, including health concerns, voiced by the community residents who live near the PGA North site and addresses the questions of suspected exposures to the contamination from the PGA North site.

2.1 Survey for Community and Former Unidynamics Workers Concerns

ADHS was asked by community residents to conduct an investigation into the various concerns of the residents in the Goodyear area and former Unidynamics workers. Although ATSDR public health assessments are not designed to address worker issues, the ADHS agreed that it would conduct a general survey of the concerns of the residents and former Unidynamics workers. A general survey of concerns can be used to address community concerns that otherwise may not be identified, provide environmental health education to clarify confusing issues for residents, and assist in determining if further investigations may be needed.

One previous resident has been particularly active in developing an awareness about the contamination on the PGA North site in the Goodyear community and with former Unidynamics workers. She is concerned that many community residents and former Unidynamics workers were exposed to the contamination at the Unidynamics facility and are experiencing adverse health effects. On behalf of her father, a former Unidynamics worker who is ill, and other Unidynamics workers, her goal is to have these issues brought out in the open and addressed in this public health assessment.

ADHS agreed to develop and conduct the survey with the understanding that this survey would not constitute a scientific investigation or epidemiological study on health conditions in the area. The survey described in this public health assessment cannot be used to identify the cause of any specific health problems in the community nor can it identify past exposures and link them to present health problems.

2.1.1 Survey Design and Process

In response to the community's request, ADHS developed an exposure history questionnaire that was used in the survey. The purpose of the exposure history questionnaire was threefold:

- 1) To determine the source of drinking water of the caller (possible sources being private or municipal wells). This allowed ADHS to clarify the community's concerns related to drinking water issues.

- 2) To identify and address the various concerns, including health concerns, of community residents and of former Unidynamics workers. This process helped the ADHS staff to address community concerns on a one-to-one basis to correct many of the misunderstandings and to avoid confusion that residents have related to the site.
- 3) To provide environmental health education materials to residents in the area.

Former Unidynamics workers were asked to describe the type of work they did at the plant and the working conditions. In addition, participants were asked if they smoked or were exposed to cigarette smoke in the home, and if they had any hobbies where they were exposed to chemicals, metals, or fumes. Copies of the exposure history forms used for the survey are included in the Appendix.

At the request of Goodyear residents, ADHS submitted public service announcements to area newspapers on several occasions to inform residents that a public health assessment was being conducted for the Goodyear area and to encourage them to participate in the survey process. Several residents became actively involved by calling other residents and former Unidynamics workers encouraging them to participate in the survey, and to express their questions and concerns about living near the PGA North site. Reporters from the local press contacted ADHS staff on a regular basis to obtain updated information on the survey, the health assessment, and other site related issues.

When Goodyear residents called ADHS, they were asked to answer the questions on the exposure history questionnaire. Many community residents provided ADHS with additional names to contact. ADHS contacted those residents, who were then asked to answer the questions on the exposure history questionnaire. Those residents that could not be reached by telephone were sent a letter explaining the public health assessment process and an exposure history form.

Residents were informed both verbally and in writing that the preliminary survey was not a scientific survey but was a means of identifying and addressing various community concerns related to the PGA North site. If a caller had health concerns, they were told that the information would not be used to make any medical diagnosis, or to determine if any health condition was related to living near the PGA North site or previous employment at the Unidynamics plant. The ADHS sent packets to residents that contained information on the chemicals of concern at the site (TCE and perchlorate), on exposure pathways (fact sheets), on the public health assessment being conducted at the site, and on historical site background (USEPA newsletters). Many callers were very appreciative of the time ADHS staff spent addressing their concerns and for the specific information sent to them. At the request of a former resident and other community residents, the ADHS sent site-related toxicological information (including diagnosis and treatment of exposures) to 20 doctors in the surrounding area.

2.1.2 Survey Results

Survey activities were conducted between May 1999 through August 1999. A total of 81 exposure histories were taken. Thirty-one questionnaires were from former Unidynamics employees, and the remaining 50 were from community residents who lived or had lived in the area at some time since 1960. Many of the former workers still live in the area, but they were included in the former workers' category. There were many concerns, including health concerns, and questions from the residents and former Unidynamics workers that were related to living near the PGA North site or previous employment at the former Unidynamics facility. The major concerns and questions are described below and then addressed in the following sections.

- ◆ Many of the community callers believe that their health problems are due to living near the PGA North site. Many residents are concerned that their children are also being exposed to the chemicals still present on the PGA North site.
- ◆ Former workers are concerned that their past exposures to the chemicals used at the Unidynamics facility have caused their current health problems. From their descriptions, direct long term inhalation and dermal contact with TCE and other chemicals occurred to many workers for many years while working at the Unidynamics facility.
- ◆ A majority of the callers are concerned that their drinking water is contaminated with TCE or perchlorate even if the source is municipal water from Goodyear or Litchfield water companies. ADHS was contacted by several residents of Park Shadows Apartments who are concerned that their drinking water, which comes from private wells, is contaminated.
- ◆ Many callers are afraid that the thermal oxidizer emissions polluted the air while in operation and have created subsequent health problems for residents throughout the Goodyear area. Some callers believe that the thermal oxidizer is still operating and the USEPA is lying to them that it has been turned off.
- ◆ Many callers believe that high rates of cancer are prevalent throughout the Goodyear area and that this has been caused by the contaminants at the PGA North site.
- ◆ Some callers said that they were healthy until they moved to the Goodyear area and began to have health problems.
- ◆ Some residents have no concerns about living near the PGA North site and called because they were curious about the remediation activities.
- ◆ Some residents think that the problem with the PGA North site is being blown out of proportion and wish it would go away.

The health conditions that were expressed are self-reported, and are not medically confirmed. Since the results are not medically confirmed (with a few exceptions), the survey data should not be used to make conclusive statements concerning the health of the residents who live near the PGA North site or those persons who worked at the Unidynamics facility.

Although ADHS staff tried to detail as much information as possible on each survey participant, this does not ensure that all pertinent information was captured. There were many factors present during the survey that allowed for uncertainty and bias in the results, as well as misleading information possible with any self-reported survey. First, participants provided information on their health conditions using different terminology and description, especially for health problems that have not been medically diagnosed. Fibromyalgia can be described in many ways including body and muscle pain, nerve pain, and even arthritis depending on the person's interpretation. Second, several ADHS staff were involved in taking the surveys. This allows for differences in how the information was interpreted and captured affecting the results. Third, participants in self-reported surveys tend to be the residents who have health problems making it difficult to find residents who are healthy. These factors can lead to a bias analysis of the results. Despite these problems, the survey provided enough information for the ADHS to identify some of the concerns that need to be addressed for the community surrounding the PGA North site.

The survey was divided into two groups. One group included community residents or previous residents who had lived in the Goodyear area or surrounding area for a period of time, but had never worked at the Unidynamics facility. The second group was comprised of former Unidynamics workers, including both those who had lived in the Goodyear area and those who had not lived in the Goodyear area.

2.1.2.1 Results of Health Survey Component for Community Residents

There were 50 exposure histories taken for community residents. The most common health problems described by community residents were breathing and other respiratory problems (including asthma), and hypothyroidism. Secondary to these were: gynecological problems, fatigue, headaches, diabetes, heart problems, and high blood pressure. Other conditions that were less frequently reported by residents were Alzheimer's disease, anemia, arthritis, epilepsy, hepatitis, hysterectomy, kidney problems, lupus, multiple chemical sensitivity, pituitary gland problems, Soren's syndrome, and skin rashes. Three cases of skin cancer including melanoma were reported. Two cases of breast cancer and lymphomas were reported. One case each of the following types of cancer were also reported: bone, brain, colon, esophageal, and lung.

2.1.2.2 Results of Health Survey Component for Former Workers

Of the 31 exposure histories on former workers, the most common health complaints included asthma and other respiratory problems, and heart, nerve and eye problems. Other symptoms less often reported included arthritis, fibromyalgia (a nerve condition of the muscles), headaches,

hypothyroidism, throat problems, and skin rashes. Six cases of skin cancer including malignant melanoma, two cases of lung (one which is extremely rare) cancer, and one case of male breast cancer, throat cancer, adult leukemia, lymphoma, and rectal cancer were reported in this group.

2.1.2.3 Results of Health Survey for Both Groups

The most common health complaint stated by both groups were respiratory problems including asthma. Many of the participants, some of which had moved to the Goodyear area within the past five years, stated that they started having respiratory problems after moving to Goodyear. Many residents believe this is due to the contamination at the PGA North site.

3.0 Environmental Contamination and Other Hazards

This public health assessment evaluates if a public health hazard exists to residents living near the PGA North site. To assess the potential adverse health effects of environmental contamination to the surrounding community near the PGA North site, the concentration of the contaminant in a specific medium (soil, air, or water) is compared to a screening value for that contaminant in that particular medium. The screening value is used to identify the chemicals that need to be evaluated in site-specific detail in the public health assessment.

There are several types of screening values which are dependent on the type of exposure pathway (dermal, ingestion, and inhalation) and the medium in which the contaminant is found (soil, air, or water). The screening levels are calculated using conservative health protective assumptions. These provide guidance in determining if the level of a chemical could present a public health hazard to nearby populations. If the concentration of the chemical is below the screening value, adverse health effects would not be expected. If the chemical concentration is above the screening value, then it is called a contaminant of concern (COC) and is further evaluated to determine if adverse health effects are likely to occur. The different screening levels used in this PHA are described below.

Soil Screening Levels

Site-specific soil contaminant concentrations are compared to Soil Remediation Levels (SRLs) to determine which soil contaminants will be evaluated further in the Public Health Assessment. SRLs for soil ingestion are calculated by ADHS, Office of Environmental Health using a human health-based approach that is generally consistent with risk assessment methodologies. SRLs protect against toxic doses of systemic toxicants, and limit excess lifetime cancer risk to one-in-one million (10^{-6}) for known human carcinogens and to one-in-one hundred thousand (10^{-5}) for possible and probable human carcinogens. ATSDR accepts the Arizona SRLs as an appropriate screening level that can be used for site purposes. Chemical concentrations in soils that exceed SRLs may not necessarily represent a health risk. Rather, when contaminant concentrations in soil exceed these standards, further evaluation may be necessary to determine whether the site poses an unacceptable risk to human health (ADHS 1997a).

Groundwater Screening Levels

Groundwater contaminants found in private wells were compared to the USEPA maximum contaminant levels (MCLs). The MCLs are enforceable drinking water regulations that are protective of public health to the extent feasible in public water supplies. If levels of contamination in a well were found above the MCL, then exposure intakes were calculated and compared to the ATSDR minimal risk levels (MRLs).

The selected list of contaminants of concern (COCs) indicates which contaminants will be evaluated further in the public health assessment. It does not mean that the listed contaminant will cause adverse health effects from exposures. The following sections present the levels of contaminants found in soil and groundwater and compare them to the appropriate comparison values. This will identify the COCs that need to be evaluated further to determine if they present a public health threat to the residents who live near the PGA North site.

3.1 On-Site Contamination

3.1.1 On-site Soil Contamination

The Unidynamics facility is completely fenced off to prevent public access. Prior to 1978, waste solvents were disposed of in four dry wells on the Unidynamics property. In 1989, during the remedial investigation at Unidynamics facility, 51 volatile organic compounds (VOCs) were found in the on-site soil, including trichloroethylene (TCE), methyl ethyl ketone (MEK), isopropanol, trichloroacetic acid (TCA), toluene, and acetone. Table 1 lists the 1989 soil contaminants and their comparisons to nonresidential SRLs (Crane 1989).

Table 1: On-site Soil VOC* Contaminants Concentrations and Comparison to SRLs[†].			
Chemical	Range (ppm [‡])	Occupational SRL (ppm)	Above SRL?
TCE [§]	<1.0 - 5,586	70	YES
MEK [¶]	<1.0 - 179	27,000	NO
Isopropanol	<1.0 - 962	10,000	NO
TCA ^{**}	<1.0 - 42	4,500	NO
Toluene	<0.5 - 6	70	NO
Methanol	<1.0 - 48	340,000	NO
Acetone	<1.0 - 232	8,800	NO

* VOC = volatile organic compound; [†] SRLs = soil remediation levels; [‡] ppm = parts per million; [§] TCE = trichloroethylene; [¶] MEK = methyl ethyl ketone; ^{**} TCA = trichloroacetic acid;

TCE concentrations were below the respective nonresidential SRL until depths of approximately 34 feet deep with the highest TCE soil concentrations found at 39 - 50 foot depths. The highest

TCE concentration in surface soil (0-2ft.) was 0.2 ppm. Concentrations of acetone, MEK, toluene, isopropanol, TCA, and methanol were below their respective SRLs. ADHS was unable to obtain more recent soil data. According to Malcolm Pirnie (consultant for Crane Co.), the levels of these chemicals have been reduced since remediation activities (air stripping, well injection) began in 1994. If surface runoff has occurred, it would not be a problem since the surface levels of TCE are below the SRL.

Chemical analyses for metals in samples from the dry wells and sedimentation tanks indicate that seven of the 11 metals that were analyzed were found above background concentrations. These included aluminum, barium, arsenic, mercury, lead, chromium and zinc (Dames & Moore 1988). These levels have also been reduced since the remediation activities began. The 1989 metals concentrations are provided below in Table 2.

Table 2: Highest 1989 On-site Soil Metals Concentrations and Comparison to SRLs*.			
Metal	Highest Concentrations (mg/kg †)	SRL (mg/kg)	Above SRL?
Aluminum	80,000	1,000,000	NO
Barium	3,240	110,000	NO
Arsenic	110	10	YES
Mercury	4.0	180	NO
Lead	3,100	2,000	YES
Chromium	290	4,500	NO
Zinc	4,200	510,000	NO

* SRLs = soil remediation levels; † mg/kg = milligrams per kilogram.

As shown on Table.2, the 1989 concentrations of arsenic and lead were above the respective SRLs. Pesticides were found in concentrations that were representative of background concentrations in agricultural areas. ADHS does not have available data to determine the type or amount of radioactive materials that were used at the facility.

3.1.2 On-site Groundwater Contamination

As of February 1999, Subunit A had levels of TCE that range from less than 1.0 micrograms per liter (µg/L) to 4,500 µg/L with the highest concentrations on-site (Crane 1989). Perchlorate was found in Subunit A in an on-site monitoring well at 81 µg/L. The Subunit B/C has levels of TCE ranging from non-detect to 4 µg/L with the highest concentrations being on-site. Table 3 below shows the concentrations of TCE and perchlorate in the two subunits compared to MCLs (ADEQ 1999; Malcolm Pirnie 1999a).

Table 3: Current On-site TCE* and Perchlorate Concentrations in the Two Groundwater Subunits Compared to MCLs[†].				
Subunit	Range of TCE Concentrations (µg/L[‡])	Above TCE MCL? (5 µg/L)	Range of Perchlorate Concentrations(µg/L)	Above Perchlorate HBGL[§] (31.5 µg/L)
A	ND - 4500	YES	ND ^e - 81	YES
B/C	ND - 4	YES	ND	NO

TCE = trichloroethylene; [†] MCL = maximum contaminant level; [‡] µg/L = micrograms per liter; ND= not detected
[§] HBGL = health-based guidance level.

The drinking water for the Goodyear municipal wells comes from Subunit C. The Goodyear Well #10 is the only municipal well in the groundwater plume area. TCE has never been detected in this well. As can be seen from Table 3, perchlorate has not been detected in Subunit B/C.

3.1.3 Past On-site Thermal Oxidizer Emissions

The thermal oxidizer was in operation intermittently from 1994 to 1998 during which time it was periodically tested for removal efficiency of the on-site soil contamination. The thermal oxidation system was turned off in October 1998 to evaluate the need for continued soil remediation at the Unidynamics facility.

According to the data provided by Malcolm Pirnie and CH2MHILL, the only chemical that was analyzed in the emissions since January 1996 was TCE. The levels of TCE detected in the emissions ranged from 0.25 µg/L to 59 µg/L during the years 1996 to 1998 (CH2MHILL 1999b). Although pilot testing was conducted in 1993, emissions data from June 1994 to December 1995 were not available. Tests for dioxin were not normally included in the monitoring tests that were conducted on the thermal oxidizer at the Unidynamics facility.

According to the National Research Council (NRC), the release of dioxins from a thermal oxidizer unit is dependent on several factors. These include the type of chemicals and chemical mixtures, the internal temperature of the unit while in operation, and whether the unit is equipped with a quencher. According to Therm Tech, the manufacturer for the thermal oxidizer at the Unidynamics facility, when their units are operated properly and have the correct pollution equipment, there is no release of dioxins (Therm Tech.1999). ADHS was unable to get data to verify this statement.

As stated in the NRC report on *Waste Incineration and Public Health*, all types of organic chemicals, including polychlorinated dioxin/furans, can be destroyed under high-temperature oxidizing conditions. Destruction can occur at around 1800 ° Fahrenheit (°F) or higher if oxygen and organic molecules are well mixed as in practical combustion devices. Destruction of polychlorinated dioxins/furans present in the waste feed stream can take place at temperatures as low as 1350 °F if oxygen and organic molecules are perfectly mixed. However, dioxins and furans are also produced within the incineration process from precursors that are not destroyed

below 1,800 ° F. Although dioxins/furans may be present in the incoming mixture, most of the dioxins/furans in the exhaust gases are the products of formation within the incinerator and not persistence of the compounds present in the waste stream (NRC1999, p.3-19). According to Malcolm Pirnie, the internal temperature of the thermal oxidizer when in operation was around 1,600 ° F (Malcolm Pirnie 1999b).

Without proper emissions data, the ADHS cannot determine if, or how much, dioxin was present in the emissions from the thermal oxidizer on the Unidynamics facility and whether the emissions presented a public health hazard to community residents in the past.

There is also an air stripper at the facility which is used to remediate the contaminated groundwater. The TCE is routed through granular activated carbon and adsorbs to the carbon. The carbon must be changed out periodically in order for the system to effectively remove the TCE before it is released into the outside air. Thus, proper operation of the air stripper and carbon vessels is very important. If improperly operated, it could result in a release of TCE to the air. ADHS does not have available data to evaluate whether this unit has been or is currently being correctly operated.

3.2 Off-Site Contamination

The off-site contamination consists of a groundwater plume that extends from the Unidynamics facility northward for approximately 2 miles.

3.2.1 Off-Site Groundwater Contamination

Globe and SunCor Private Wells

There are seven private irrigation wells and one private domestic well located on the northern portion of the groundwater plume. Three of these wells are known as the Globe Wells #1, #2, and #4 and are located west of Bullard Road. The other 4 wells, known as the SunCor wells, are located east of Bullard Road.

Globe Well #1, which is located behind the house on Bullard Road, and Globe Well #2, located further west from Globe Well #1, provide irrigation water to the small irrigation canals that parallel the RID on the south side to the west of Bullard Road. Globe Well #4 is located in the middle of the fields. SunCor irrigation wells #33A, #33B, and #33C located on the northern end of the groundwater plume. SunCor Well #33A has a permanent activated carbon treatment system and is being incorporated in the final groundwater remedy. Water from this well is being used to irrigate the golf courses and decorative lakes in Pebble Creek and will be similarly used for the new SunCor housing development which is being built east of Bullard Road. SunCor Well #33B is used only for emergency purposes. SunCor Well #33C has been abandoned.

The MCL for TCE is 5 µg/L. Since perchlorate does not yet have an MCL, it is compared to ADHS's interim screening level known as the health-based guidance level (HBGL) for

perchlorate of 14 µg/L. The Globe Well #1 and #2 have levels of TCE above the MCL. SunCor Well #33A has elevated levels of TCE but this is corrected with the use of a carbon filter system. All the wells that were tested for perchlorate had levels below the HBGL. Tables A1 - A10 in the Appendix summarize the sampling data of these wells from 1997 to 1999 (Malcolm Pirnie 1999a).

The irrigation water from the Globe wells flows into a holding pond located nearby between the RID and the small canals. According to the ADEQ, the holding pond which is owned by the Globe Corporation, has never been tested for contaminants. The irrigation water is cycled through the fields and held in the holding pond until further need arises. It is safe to assume that the water in the holding pond has traces of TCE and perchlorate as does the irrigation water in the small canals since they are connected. Table 4 provides a summary of the TCE and perchlorate levels found in the Globe and SunCor wells and comparisons to the appropriate screening levels (Malcolm Pirnie 1999a; ADEQ 1999).

Table 4: TCE[*] and Perchlorate Concentrations in Private Irrigation/Domestic Wells (February 1997 - February 1999).						
Well	TCE			Perchlorate		Comments
	Range µg/L [‡] (before filter)	Filter system?	Above MCL [§] of 5 µg/L?	Range (µg/L)	Above HBGL [¶] of 31.5 µg/L?	
Globe #1	39	NO	YES	ND**	NO	Used for irrigation 20 days/month.
Globe #2	ND - 25	NO	YES	5	NO	Used to irrigate fields west of Bullard Road.
Globe #4	ND - 1	NO	NO	NS ^{††}	NS	Is minimally used for irrigation.
Globe Domestic	19 - 250	YES	< 1.0 (after filter)	ND	NO	Used as drinking water.
SunCor 28A	ND-<1	NO	NO	NS	NS	---
SunCor 29A	ND-< 1	NO	NO	NS	NS	---
SunCor 33B	ND-< 1	NO	NO	NS	NS	Rarely used.
SunCor 33A	340 - 490	YES	ND (after filter)	NS	NS	Used for golf course and decorative lakes in Pebble Creek and the new SunCor developments.
SunCor 33C	ND- 270	NA ^{†††}	NA	6	NO	Abandoned.

TCE = trichloroethylene; [†] PGA = Phoenix Goodyear Airport; [‡] µg/L = micrograms per liter; [§] MCL = maximum contaminant level; [¶] HBGL = health-based guidance level; ** ND = not detected; ^{††} NS = not sampled; ^{†††} NA = not applicable.

Results shown in Table 4 indicate that the treatment system on the Globe Domestic private well and the SunCor Well #33A continues to be effective in decreasing the TCE concentrations to <1 µg/L which is below the MCL of 5 µg/L. Photographs of the Globe and SunCor wells, the connecting canals, and holding pond are located in the Appendix.

Park Shadows Apartments Private Wells

Park Shadows Apartments are located on Litchfield Road approximately one-half mile south of the Unidynamics plant encompasses 44 square acres. There is a drinking well and an irrigation well located on the grounds. The drinking well, which draws water from the Subunit B/C aquifer which is clean, has been regularly sampled over the past several years and has never had any detection of TCE. The irrigation well is screened at a higher level and pulls water from Subunit A. According to the ADEQ, TCE concentrations in the irrigation well have been detected at 2.2 µg/L twice over the past 10 years. However, in March 2000, TCE was detected at a level of 23 µg/L in the irrigation well. ADEQ has strongly advised the Park Shadows Apartments management not to change the irrigation well into a drinking water well. Table 5 provides the concentrations of TCE in the wells at the Park Shadows Apartments.

Table 5: TCE* Concentrations in Private Wells at Park Shadows Apartments			
Wells	TCE (µg/L[†])	Above MCL[‡]?	Perchlorate
Irrigation Well	ND [§] - 23	NO	NS [¶]
Drinking Water Well	ND	NO	NS

TCE = trichloroethylene; [†] µg/L = micrograms per liter; [‡] MCL = maximum contaminant level; [§] ND = not detected; [¶] NS = not sampled.

As can be seen from Table 5, TCE has been detected in the irrigation well at the Park Shadows Apartments at levels above the federal MCL. The private wells at Park Shadows have not been tested for perchlorate.

In this section, TCE was identified as a COC in on-site soil. Both TCE and perchlorate were identified as COCs in on-site groundwater. TCE was identified as COC in off-site groundwater. These COCs will be further evaluated based upon a toxicological evaluation in order to determine if they present a public health threat.

4.0 Exposure Pathway Analysis

In order to determine if residents are being exposed to the chemicals at levels of public health concern at the site, pathways are identified to determine if and how residents are being exposed to the contaminants. A resident can only be exposed if a pathway is completed at levels of public health concern. Pathway analysis considers the source of contamination, the transport of the contaminant through environmental media, an exposure point, a potential route of exposure, and

the existence of a receptor population. Both current and future potential pathways are evaluated.

4.1 Incomplete Exposure Pathways

Incomplete current exposure pathways indicate that the contamination is present but is not able to reach the surrounding population for a variety of reasons.

On-site Soil and Groundwater Contamination

The Unidynamics property is fenced off preventing any public access to the site and exposures to the soil and groundwater contamination. Unidynamics used to dump some of their waste in an area near the mountains just west of the facility known as White Tanks. The investigation of the contamination at White Tanks is still being conducted.

Thermal Oxidizer Emissions

The thermal oxidation system was turned off in October 1998 to evaluate the need for continued soil remediation at the Unidynamics facility. Currently, no one in the Goodyear area is being exposed to the emissions from the thermal oxidizer.

Future exposures to thermal oxidizer emissions will not occur unless the thermal oxidizer is put back into operation. USEPA is in the process of deciding if the thermal oxidizer is needed for further on-site soil remediation. If the thermal oxidizer is put back into operation, ADHS will request to review and evaluate the proposed sampling plan for testing air emissions to ensure it is protective of public health. In addition if the thermal oxidizer is used again, ADHS will request the air emissions data to evaluate and determine if a public health threat exists.

Off-site Groundwater

SunCor Well # 33A, which has a carbon filter treatment system, is currently being used to provide water for the ornamental lakes and golf course in the Pebble Creek housing development. Use of the treated water does not represent a health hazard if the carbon treatment system is functioning properly.

4.2 Complete Past, Current, and Future Exposure Pathways

Past Occupational Exposure Pathways

It is known from our preliminary overview that many former Unidynamics workers were exposed to TCE and other chemicals in their jobs on a daily basis. These would have included inhalation, ingestion, and dermal exposures to the various chemicals used at the plant. Their reports indicated that they were exposed to many different chemicals including nitric acid, tear gas, MEK, hydrochloric acid, explosive chemicals, radioactive materials such as tritium and cobalt, and TCE while performing different types of jobs.

Past Air Emissions Exposure Pathways

Past thermal oxidizer emissions could have led to inhalation exposures for residents living nearby the unit. Because many community residents are concerned about their past inhalation exposures to the thermal oxidizer emissions, ADHS has calculated past inhalation exposure doses from the available emissions data. These are presented in Section 5.1.1.1.

Current and Future Exposure Pathways

It is possible that dermal, inhalation, and ingestion exposures have occurred and will continue when farmworkers irrigate the fields, and when children play in the irrigation water in the small canals or at the Park Shadows Apartments. Additional exposures may also occur if the abandoned wells in the area are fixed and used for drinking or irrigation purposes, or if an irrigation well is converted into a drinking water well. Photographs of the Globe wells, small irrigation canals, and nearby irrigation water holding pond are provided in the Appendix.

Approximately 2,000 homes have been built in the Pebble Creek housing development, of which 1,500 are currently sold. It is anticipated that approximately 6,000 residents will soon be living in this area assuming three residents per house. The new SunCor housing development that is currently under construction will have approximately 3,500 homes and 10,500 residents. Construction for the new Globe housing development, which will be located just west of Bullard Road and south of the Roosevelt Irrigation District (RID) canal, has not yet begun but approximately 2,000 homes are planned bringing in approximately 6,000 new residents into the area. The Globe Corporation, who owns the land west of Bullard Road, stated that the Globe wells may be shut down when housing construction begins since they won't be needed for irrigation purposes.

Table 6 provides a description of the past, current and potential future exposure pathways that have been identified and the estimated surrounding population at risk. These estimates assume three persons per residence.

Table 6: Summary of Exposure Pathways.

Source	EXPOSURE PATHWAY ELEMENTS					Time
	Media	Point of Exposure	Route of Exposure	Estimated Population [†]	COC [‡]	
Unidynamics	air soil groundwater	air emissions soils groundwater	ingestion inhalation dermal	300	TCE [§]	past
Thermal Oxidizer	air	air emissions	inhalation	400	TCE	past
Park Shadows Apts.	groundwater	water used for irrigation purposes	ingestion dermal inhalation	600	TCE	past current future
Globe #2 Well	groundwater	water in irrigation canals	ingestion dermal inhalation	10 farmworkers	TCE perchlorate	past current future
Globe #2 Well & SunCor #33A	groundwater	irrigation water for canals, golf courses, & ornamental lakes	ingestion dermal inhalation	Pebble Creek 4,500 res. [¶] (2,000 homes)	TCE perchlorate	past current
Globe #2 Well & SunCor #33A	groundwater	irrigation water for canals, golf courses, & ornamental lakes	ingestion dermal inhalation	Pebble Creek 4,500 res. (2,000 homes) SunCor 10,500 res. (3,500 homes) Globe 6,000 res. (2,000homes)	TCE perchlorate	future

* PGA= Phoenix Goodyear Airport; [†] Assumes three residents per household; [‡] COC = contaminants of concern; [§] TCE = trichloroethylene;

[¶] res.= residents

5.0 Public Health Implications

5.1 Toxicologic Evaluation

The potential for adverse health effects in persons exposed to site-specific contaminants through current or future exposure pathways has been analyzed by ADHS. Some children could be exposed to TCE and perchlorate if they play or drink the water in the small irrigation canals or in the holding pond located next to the larger RID canal. Two of the Globe irrigation wells have concentrations of TCE at levels which are above USEPA's MCL. TCE was also recently detected in the irrigation well at the Park Shadows Apartments at a level which is above the federal MCL. Concentrations of perchlorate were found in Globe Well #2 irrigation well but the level was not above the health-based guideline value. Based on these facts, TCE is the only contaminant of concern which merits detailed evaluation.

5.1.1 Health-Based Guidance Levels (HBGLs)

Health-Based Guidance Levels (HBGLs) are tools used to assist in evaluating the public health risk posed by each specific contaminant of potential concern. They are calculated by ADHS using a human health-based approach that is generally consistent with risk assessment methodologies recommended by ATSDR and USEPA. ADHS has used standard exposure assumptions, and, where necessary, has made conservative assumptions based upon research of the particular exposure scenario and professional judgement. Equations used to quantify exposures were based upon generally accepted methods, models, toxicity values, and assumptions developed by USEPA. The standard exposure assumptions were obtained primarily from *Risk Assessment Guidance for Superfund (RAGS), Supplemental Guidance Standard Default Exposure Factors* (USEPA 1991). The risk management values used to calculate the HBGLs are consistent with the methodology used to calculate the Arizona residential Soil Remediation Levels (SRLs). HBGLs protect against noncancer health effects, and limit excess lifetime cancer risk to one-in-one million (10^{-6}) for known human carcinogens and to one-in-one-hundred-thousand (10^{-5}) for possible and probable human carcinogens.

Health-Based Guidance Levels (HBGLs) are individually protective of human health, including sensitive groups, over a lifetime. Chemical concentrations that exceed the applicable HBGL may not necessarily represent a health threat. Rather, when contaminant concentrations exceed the HBGL, further evaluation may be necessary to determine the potential public health risk. The HBGLs calculated in this public health assessment consider the human health threat from the cumulative inhalation, ingestion and dermal contact with TCE in the small irrigation canals. They were also calculated for inhalation contact with TCE in the emissions that came from the thermal oxidizer.

5.1.1.1 Health-Based Guidance Levels (HBGLs) for Past On-site Thermal Oxidizer Emissions

The ADHS calculated an annual ambient air HBGL for TCE levels that were detected in the emissions of the thermal oxidizer during the time it was in operation to determine if residents were exposed to levels of TCE that could affect their health. The highest TCE level detected was used in the calculations, which assumed that people were consistently exposed to that level for 30 years, 350 days per year. The exposure duration for carcinogens was assumed to be 30 years, with six of those years as a child and 24 years as an adult. Since exposure to contaminants in air may be different for children and adults, carcinogenic risks during the first 30 years of life were calculated using age-adjusted exposure factors. These factors integrate exposure from birth until age 30, combining contact rates, body weights, and exposure durations for small children and adults. Exposure doses were averaged over a lifetime (70 years) for carcinogens.

Annual HBGLs are also specifically protective of noncancer health effects for childhood exposure. Exposure assumptions reflect childhood inhalation rates and body weight. The focus on children is protective of the higher daily intake rates by children relative to their body weight. For noncancer health effects, the exposure duration was assumed to be 350 days per year for six years. Exposure doses are averaged over the period of exposure (six years) for noncancer health effects. Air HBGLs use the default childhood inhalation rate of 10 cubic meters per day (m³/day) and default body weight of 15 kilograms (kg) (USEPA 1989,1991).

The ADHS used a “box model” to calculate the movement of the emissions from the stack of the on-site thermal oxidizer into the residential areas of Goodyear (ADHS 1997). It assumes the air is well-mixed within the box and the dimensions of the box are equal to the human breathing zone height and the length of the emission source in the predominant wind direction. Given these assumptions, ADHS estimated outdoor ambient air TCE concentrations of 0.0016 mg/m³ due to the past vapor emissions from the thermal oxidizer on the Unidynamics facility.

Table 7 displays the estimated outdoor TCE air concentration using the highest TCE concentration detected in the available thermal oxidizer emissions data. This outdoor air concentration was then compared to the HBGL to determine if the TCE in the emissions presented a health threat when the thermal oxidizer was in operation.

Table 7: Estimated Outdoor Air Concentrations of TCE* in the Thermal Oxidizer Emissions and Comparison to the HBGL[†] (1996 through 1998).			
Range of Emission TCE Concentrations	Estimated Outdoor Air TCE Concentration in Emissions	Ambient Air HBGL for TCE	Above HBGL?
0.25 - 59.0 µg/L [‡]	0.0016 mg/m ³ [§]	0.009 mg/m ³	NO

* TCE=Trichloroethylene; [†] HBGL=Health-based Guidance Level; [‡] µg/L = micrograms per liter; [§] mg/m³ = milligrams per cubic meter.

As can be seen in this table, the concentrations of TCE in the past emissions from the on-site

thermal oxidizer did not exceed the HBGL. This indicates that the level of TCE in the emissions would not be considered a health threat to the community even if the thermal oxidizer operated for 30 years. But this is not applicable to dioxin emissions since it they were not tested for during the time the thermal oxidizer was in operation.

5.1.1.2 Health-Based Guidance Levels (HBGLs) for the Contaminated Water in the Small Irrigation Canals

This section analyzes all the various exposure pathways that children, adults, and farmworkers may be exposed to the contaminated water in the small irrigation canals. ATSDR and ADHS standard exposure assumptions for intake rates, body weights, exposed dermal surface area, averaging times, and exposure duration were used. Equations and exposure factors are provided in Table A11-A29 in the Appendix. ADHS calculated both residential and occupational HBGLs as comparison values that would incorporate all the various exposure pathways to the contaminated water via incidental ingestion and dermal contact, and inhalation pathways.

The residential exposure scenario conservatively assumes that adults and children are exposed to the contaminated irrigation water via inhalation, ingestion, and dermal contact during periodic flood irrigation times or play activities such as playing in the canal water. A child is assumed to play in the irrigation water for 4 hours per day, 350 days per year (City of Phoenix 1998) for six years. The child is exposed via incidental ingestion and dermal contact with the contaminants in the water for a 4-hour period during each irrigation event (ADHS 1997a). An adult is assumed to have incidental contact with the irrigation water that has flooded the fields while walking next to the irrigated fields. It is assumed that the amount of time for this activity would account for one hour per day, 350 days per year for 30 years. The adult is exposed via inhalation of contaminants escaping from the flood irrigation waters for the 4 hours that the water is assumed to be standing in the property.

The occupational exposure scenario for flood irrigation quantifies exposures to workers involved in maintenance of the irrigated properties. This exposure scenario conservatively assumes that workers are exposed to contaminants in the flood irrigation water via incidental inhalation, ingestion and dermal contact during regular farming activities. A farmworker involved in flood irrigation duties is assumed to have incidental inhalation, ingestion, and dermal contact with the flood irrigation water for eight hours per day, 250 days per year for 25 years (ADHS 1997).

ADHS's HBGLs for flood irrigation indicated the highest concentration of TCE in the contaminated groundwater that would not be considered to cause adverse health effects when used for irrigation purposes in the fields. The residential HBGL for TCE is 397 µg/L for adults and 87 µg/L for children. The occupational HBGL is 100 µg/L for adults. As seen in Table 8 below, estimated exposure doses from ingestion of contaminated water from the Globe #2 well and the Park Shadows irrigation well are below the respective HBGL.

Table 8: Comparison of TCE* Concentrations in the Globe Irrigations Wells to the HBGLs†.					
Chemical Found in Private Well	Exposure Pathway	Usage of Private Well	Comparison of Exposure Intake to HBGL		
			TCE Levels in Wells	HBGL	Exceeds HBGL?
TCE	Globe #1 Globe #2 Irrigation Wells	irrigation of fields	39 µg/L‡ 22 µg/L	adult: 397 µg/L child: 87 µg/L	NO
TCE	Park Shadows Irrigation Wells	irrigation of apartment grounds	23 µg/L	occupational: 100 µg/L	NO

* TCE=Trichloroethylene; † HBGL=Health-based Guidance Level. These HBGLs assume that adults and children are exposed to the contaminated irrigation water 350 days per year; ‡ µg/L = micrograms per liter.

ADHS concludes that the TCE levels detected in irrigations wells Globe #1, #2, and Park Shadows do not represent a current public health threat.

5.1.1.3 Ingestion Exposures to Eating Edible Plants Irrigated with Contaminated Groundwater

In response to community concern, the ADHS conducted research to determine if a public health threat exists from the consumption of vegetables that could be grown in the fields that have been irrigated with the TCE contaminated groundwater. A literature search was conducted to identify how volatile organic compounds (VOCs) are taken up by edible plants and what the accessibility of the VOCs are to humans who might eat the plants. ADHS has concluded that there are insufficient data to identify the possible health threat related to the ingestion of edible plants grown with the use of contaminated groundwater.

While much of the present research has focused on the uptake of pesticides into plants, the research on the uptake of industrial pollutants by plants and food crops is rudimentary. Studies have focused on the uptake of individual organic chemicals by crops such as corn, radishes, barley, beets, wheat, and soy. However, experimental results have been inconsistent, and have been dependent on the various factors within the study.

Trapp and McFarlane (1995) have developed mathematical models to account for some of these variables in order to predict the uptake of organic chemicals into plants and the fate of different chemicals. However, the authors suggest that more data are needed for a variety of chemicals and tissues to strengthen the correlations. Consistent correlations would enable investigators to predict how much of a chemical is absorbed into the plant and its accessibility to humans.

Available data suggest that the uptake of organic contaminants by plants is dependent on the various properties of the chemical, the plant, and its environment. Until these variables can be determined and identified, any health threat to humans due to the consumption of food grown with TCE contaminated groundwater cannot be determined.

5.1.2 *Limitations of Toxicological Data*

More detailed toxicological information on TCE and perchlorate are summarized in the Appendix for reference. Each chemical is summarized with regard to use, interaction with other chemicals, exposure routes, toxicokinetics, toxic (health) effects, carcinogenicity and regulatory status. Much of this information is provided by the *Toxicological Profiles* published by the ATSDR. ADHS recognizes that the scientific literature includes limitations, such as the extrapolation of high-dose animal studies to low-dose human exposures and studies done on single chemicals while many exposures may be to complex mixtures of chemicals. ADHS has considered these factors in the evaluation of the PGA- North site.

5.2 Health Outcome Data Evaluation

5.2.1 *Evaluation of Arizona Department of Health Services (ADHS) Health Studies*

The ADHS studies reviewed in the Health Outcome Data Section 1.5, analyzed cancer and childhood leukemia mortality and incidence rates in Maricopa County, including the Goodyear area, since 1965. These studies measured the mortality of five disease categories and the incidence of childhood cancers and leukemia. These studies did not measure morbidity (illness) or any adverse health effects that do not result in death or cancer. There was no indication of elevated mortality or incidence rates of total cancers or childhood leukemia in the Goodyear area found in these studies.

If higher cancer rates had been found in the Goodyear area, no causal relationship could be drawn from these findings. Since the development of cancer has multiple risk factors and potential causes (e.g., lifestyle, genetics, socioeconomic status, and environmental), it is not possible to assume that a given disease condition is or is not caused by a specific environmental contaminant. In addition, past exposures cannot be quantified or verified eliminating the possibility of determining causation in any health study that would be conducted. Therefore, if an additional study were conducted, it would not be able to determine if any cancers in residents in the Goodyear area are due to past exposures to TCE or any other contaminants from the PGA North site.

5.2.2 *SunCor Housing Development Risk Assessment (1998)*

In 1998, a risk assessment was conducted by Papadopoulos & Associates, for the new SunCor housing development. It evaluated the human risk that residents might have from exposure to potential volatilization of TCE from contaminated groundwater beneath the SunCor housing

development in Goodyear, Arizona. The ADHS reviewed the risk evaluation to determine if the assumptions and calculations used in the report were correct.

The potential migration of TCE from the groundwater through the overlying soil area and into the air was evaluated to determine the potential TCE concentrations in air that residents might breathe. The risk assessment concluded that TCE in the groundwater does not represent a significant risk from volatilization through soil to residents who live in the SunCorp development. There are limitations to modeling indoor air concentrations. ADHS cannot determine the accuracy of the modeling results without having access to the necessary data.

5.3 Health Concerns Evaluation

This section reviews the results of the ADHS survey, and addresses the concerns that were voiced by the community residents and former Unidynamics workers.

This survey process has been extremely successful in helping the ADHS identify and address many of the concerns of the community residents and former Unidynamics workers. Residents had many misunderstandings, worries, and concerns related to living near the PGA North site. ADHS helped to clarify many of these misunderstandings, alleviate some of the community fears, and address major concerns on a one-to-one basis with community members. In addition, ADHS sent environmental health educational materials to survey participants and doctors in the area.

The community survey is meant only to be used as guidance in identifying and addressing public health and community concerns. It is not designed to be a scientific epidemiological study. Since the results are not medically confirmed (with a few exceptions), the survey data cannot and should not be used to make conclusive statements concerning the health of the residents who live near PGA North site or who worked at the Unidynamics plant.

They are deeply concerned that many of their health problems are due to living near the PGA North site and being exposed to the contamination. Since some of the health conditions that were reported, such as eye and respiratory problems, are not legally required to be reported to a registry, there is no available health outcome database to use for comparison. This makes it extremely difficult to determine if any amount of a specific illness in an area is unusual. Therefore, no conclusions can be made as to whether the community residents are experiencing unusual adverse health effects (other than those that result in death) that would be related to exposure to the chemical contamination at the PGA North site.

Former Unidynamics workers have voiced major concerns about their health problems that have developed subsequently to their employment at the plant. Some of the health problems expressed by former workers (respiratory, heart, nerve, and eye problems) are consistent with long term exposure to working with high levels of TCE. However, ADHS is unable to link the cause for these health problems directly to past exposures to chemicals at the plant since there are many

confounding factors. Because the development of cancer and other diseases have multiple risk factors and potential causes (e.g., lifestyle, genetics, socioeconomic status, and environmental), it is usually not possible to assume that a given disease condition is or is not caused by exposures to specific environmental contaminants. Past exposures of former workers at the Unidynamics plant cannot be quantified or verified. This eliminates the possibility of determining causation of subsequent diseases that former workers developed.

5.3.1 Community Residents Concerns

This section identifies and addresses the concerns of the community residents who were not former Unidynamics workers.

❑ What is Trichloroethylene (TCE)?

TCE is a clear, odorless, nonflammable liquid used for vapor degreasing of fabricated metal parts. Consumer products that contain TCE include typewriter correction fluid, paint removers and strippers, cosmetics, rug cleaners and spot removers, and adhesives. Before 1977, TCE was used as a general anesthetic, analgesic, grain fumigant, disinfectant, pet food additive, and extractant of spices and caffeine in coffee (ATSDR 1997).

5.3.1.1 Community Drinking Water Concerns

❑ Are the municipal drinking water sources in Goodyear, Litchfield, and Pebble Creek safe to use as drinking water? Is the water being monitored for harmful contaminants?

Yes. The drinking water in Goodyear, Litchfield, and Pebble Creek is safe to drink. The quality of drinking water supplied in these areas meets drinking water standards established by USEPA in the Safe Drinking Water Act amended in 1991. The municipal wells in the City of Goodyear, Litchfield Park Service Company, and Pebble Creek are monitored on a quarterly basis and there have been no detections of contaminants above drinking water standards. These standards are protective of public health. More specifically, the City of Goodyear routinely monitors wells in proximity to the TCE plume at least quarterly to ensure that the water is safe for consumption. The ADHS reviewed the past data from the samples taken from Goodyear wells #2, #3, and #10. The results show that these wells have no VOCs, including TCE at levels of public health concern. Since Goodyear well #10 is the only Goodyear municipal well that is located over the plume, it is being watched carefully to ensure that it is not contaminated.

The Crane Co. maintains 24 groundwater monitoring wells throughout the contaminated groundwater area under the direction of ADEQ. The purposes of the monitoring program are to define the horizontal and vertical extent of contamination, and to provide data on the effectiveness of the groundwater containment and cleanup program. This also helps to identify any municipal wells that may be in the path of migrating contaminated groundwater (USEPA 1999).

❑ ***How can the drinking water from the municipal wells be safe if the groundwater is contaminated?***

Groundwater is water found in large amounts under the ground surface. There are three main bodies of groundwater underneath the PGA North site that are called aquifers. Located at different depths, they are known as the upper Subunit A, middle Subunit B, and the lower Subunit C aquifers. The upper aquifer (Subunit A) contains groundwater that became contaminated from waste solvents that were disposed of in dry wells on the Unidynamics facility and is not used as a source for drinking water by the City of Goodyear. The middle aquifer (Subunit B) produces very little water and restricts groundwater from moving from the upper Subunit A to the lower Subunit C aquifer. The lower aquifer (Subunit C) is used for drinking water, agricultural and industrial purposes in the Goodyear area (USEPA 1999). The middle and lower Subunits B and C are often called the lower B/C Subunit aquifer.

TCE has been detected in a small area in the lower B/C Subunit aquifer. This contamination has not migrated to the Goodyear municipal wells. The Goodyear municipal well #10 is the only well that is located in the plume area. TCE has never been detected in this well. This situation is being monitored carefully by various agencies to prevent the municipal wells from becoming contaminated. Remediation activities are pulling the contamination away from the municipal wells so they will not become contaminated. Community residents are encouraged to call the ADHS and ADEQ for updates on this situation if they are concerned.

❑ ***Are the private wells at Park Shadows Apartments safe?***

There are two private wells at Park Shadows Apartments. One is used for irrigation purposes and the other for drinking and domestic purposes. These wells are sampled on a regular basis as determined by ADEQ. Results from past samples have found that the drinking well had no detected VOCs, including TCE. Water samples from the irrigation well have detected levels of TCE at 2.2 micrograms per liter (µg/L) consistently for the past several years. Recent samples from this irrigation well have shown levels of TCE at 23 µg/L. This is above the USEPA's MCL of 5 µg/L but below the HBGL for irrigation water. This is not considered a health hazard. The drinking water well pulls water from Aquifer C which remains free of TCE. These wells have not been tested for perchlorate. It is recommended in this report that perchlorate be tested in these wells.

❑ ***There are signs posted along the small irrigation canals that warn people not to touch the water because it is contaminated. Will my child get sick if he or she plays in that water?***

The water from the Globe wells, where the signs are posted, is contaminated with low detections of TCE and perchlorate. The water from these wells flows into the small irrigation canals that are used to irrigate the agricultural fields and is stored in the nearby holding pond. Because a new SunCor housing development is being built nearby which will bring more children into the area,

the ADHS conducted an exposure assessment to determine if the water presents a health hazard to children. The analysis showed that the levels of TCE and perchlorate are not high enough to cause health problems even if children play in the canals every day of the year. The well water is being routinely monitored by ADEQ. Even though TCE and perchlorate are present in the small canals, it won't hurt anybody who comes in contact with the water or drinks it.

However, there are several physical hazards apparent around the canal area. There are rusty broken pipes around the various pumps in the area that are accessible to children. There are large open cement drains that children can crawl into and an open well that a child could fall into. This is also a concern since new residential areas are being built nearby. Photographs of these areas are included in the Appendix.

☐ ***Are farm workers being exposed to TCE contaminated water in the small irrigation canals?***

It is likely that farm workers could be exposed to the contaminated water in the small irrigation canals when working in the fields. This would happen if they drank the water, used the water to cool themselves, or used it to wash their hands and face. The ADHS conducted an exposure assessment to determine if the water presents a health hazard to farm workers. Although the water is contaminated, the levels of TCE and perchlorate are not high enough to cause health problems, even if the farm workers come in contact with it eight hours a day for 250 days per year. The water is being monitored by ADEQ. The remediation activities that are taking place will eventually clean the groundwater and the water in the canals. Even though TCE and perchlorate are present in the small irrigation canal water, the levels will not cause adverse health effects to anyone who comes in contact with or drinks the water.

☐ ***Has there been any remediation of the groundwater in Goodyear? Will the remediation of the groundwater improve the safety and quality of the water?***

Yes. Full scale remediation (cleanup) of the groundwater contamination began on the PGA North site in September 1990. The Crane Co. established groundwater monitoring, groundwater cleanup, and soil cleanup programs to implement the required cleanup. Groundwater cleanup is being accomplished through a network of groundwater extraction and groundwater injection wells. Six groundwater extraction wells pump approximately 1,300 gallons per minute to contain and restore the contaminated aquifer.

The extracted groundwater is treated to remove the VOCs. Then it is either re-injected back into the aquifer or used for irrigation. The groundwater treatment unit removes the VOCs using air stripping technology and then treats the contaminated air coming from the unit with granular activated carbon. There has been a drastic reduction of TCE concentrations since treatment began. The extraction wells have removed approximately 26,000 pounds of VOCs from the groundwater since operation of the system began. It is estimated that the system at the Unidynamics plant will operate for at least 25 years.

❑ ***Has the presence of TCE in the groundwater resulted in higher rates of cancer in the community residents who live in the Goodyear area?***

ADHS has routinely conducted several studies to analyze the amount and types of cancer during the past three decades throughout Maricopa County. These studies also include the Goodyear area. Results from these studies show that the Goodyear area did not experience elevated mortality or incidence rates of cancer, or childhood leukemia during the years from 1965 to 1990.

According to the American Cancer Society (ACS), there are many causes of cancer. These include genetic factors, viruses such as the Epstein Barr virus which can cause various lymphomas, and the human papillomavirus (HPV) that can cause non-melanoma skin cancer, and environmental factors (ACS 1999). The ACS has available information on the different types of cancer, their causes, and treatment. Currently, no evidence suggests that the TCE in the groundwater has resulted in higher rates of cancer in the Goodyear area residents.

❑ ***Can people in the community collect chemicals in their bodies (bioaccumulation) from drinking contaminated water?***

VOCs do not significantly collect in the human body. This class of chemicals is easily processed by the body and eliminated. Therefore, exposure in Goodyear to water contaminated with TCE or other VOCs should not result in collection of VOCs in people.

How much is collected in the body depends on the chemical properties of the contaminants. One of the main factors responsible for chemicals collecting in the body is when a chemical does not break down easily in the body. Because TCE is easily broken down by the body and excreted, it is unlikely that TCE would accumulate in the body tissues of people living in the Goodyear area.

❑ ***Many residents are concerned about the presence of perchlorate in the drinking water after attending the February 1999 public meeting held by the USEPA. This concern was voiced by several people who called in during the following months after the meeting.***

The drinking water in Goodyear, Litchfield, and Pebble Creek is safe to drink and clean of perchlorate. However, there are small amounts of perchlorate in the Globe well #2 which provides water to the irrigation canals west of Bullard Road. It is not possible for the residents of Goodyear to come in contact with the perchlorate in the groundwater unless they drink, swim or rinse off in the irrigation water in the canals or holding pond. The perchlorate concentration in the irrigation canals is below the ADHS health guideline of 14 parts per billion (ppb). Nonetheless, the ADHS sent out health education information packages to doctors throughout the Goodyear area, to inform them of the perchlorate in the water, and the likelihood of any health effects from being exposed to the perchlorate.

Perchlorate originates as a contaminant in the environment from the solid salts of ammonium,

potassium, or sodium perchlorate. The perchlorate part of the salts is quite soluble in water and can persist for many decades under typical groundwater and surface water conditions, because of its resistance to react with other available elements. Perchlorates dissolve easily in water and are quite capable of migrating to groundwater.

Perchlorates are used in pyrotechnics, explosives and jet or rocket fuels. They are also used as catalysts or as digesting agents in analytical chemistry laboratories, as etching and engraving agents, as an ingredient in electrolytic baths in depositing lead and electro-polishing and in the manufacture of various chemical compounds. Perchlorates can be used in oxygen-generating devices for life-support systems in submarines, space ships, bomb shelters and breathing apparatuses. Perchlorates can be used in paper and wooden matches and automobile air bags.

Potassium perchlorate is used to treat Grave's disease, an autoimmune disorder that affects the thyroid function leading to a hyperthyroid state. Perchlorate can interfere with the function of the thyroid. When this happens, the pituitary gland responds to the low level of hormones by producing thyroid-stimulating hormone (TSH) causing the thyroid gland to become enlarged. This can cause hypothyroidism where people can feel sluggish, depressed, cold, or tired. There are many causes for hypothyroidism. Thyroid disorders are very common, and are more frequent in females than in males.

USEPA is in the process of developing a federal standard for perchlorate that will be based on the research currently being conducted around the country. ADHS uses the health-based guidance level in the interim. As stated earlier, it is not possible for the residents of Goodyear to come in contact with the perchlorate in the groundwater unless they drink, swim or rinse off in the irrigation water in the canals or the holding pond.

5.3.1.2 Community Concerns Related to Air Pollution

- ❑ ***Thermal Oxidizer: Several Goodyear residents expressed concerns about the thermal oxidizer, which was set up to remediate the soil at the Unidynamics facility. These residents wondered if, while the thermal oxidizer was still in operation, they had been exposed to cancer-causing compounds, such as dioxins and furans that could have been present in the emissions.***

The thermal oxidizer was in operation intermittently from 1994 to 1998. It was periodically tested for TCE removal efficiency of the on-site soil contamination. It was turned off in October 1998 to assess whether further soil remediation was needed. Presently, no one is being exposed to the emissions from the thermal oxidizer.

The dioxin emissions from a thermal oxidizer are dependent on the type of air pollution control equipment being used, the chemicals that are being burned, internal temperatures, and other operating conditions. Therm Tech, the manufacturer of the thermal oxidizer at the PGA North site, stated that this unit has all the necessary components to prevent dioxins from being formed.

The unit has a quencher; it provides good mixing of the combustion gases enough to prevent dioxins from being created in the oxidizing chamber. ADHS was not able to get testing data on dioxin levels in emissions from other thermal oxidizers.

Chemicals in the emissions, including dioxins, from the thermal oxidizer will become diluted when they are released into ambient air. However without proper data, ADHS cannot determine if or how much dioxin was present in the past emissions from the thermal oxidizer at the PGA North site. The emissions data for the thermal oxidizer at the PGA North site includes only TCE since that is what was being removed from the soil. Past emission data and exposure dose analysis for TCE is provided in Section 5.1.1.

ATSDR reports that the average American adult has a circulating level of dioxin of seven picograms per gram (seven parts per trillion) of body fat (ATSDR 1998). It is estimated that the daily intake of dioxins and furans by a maximally exposed individual living near a modern thermal oxidizer is only 0.9% of the total daily intake and 99.1% is from other various sources, primarily meat and dairy products (ATSDR 1998, p.467).

☐ ***Since the thermal oxidizer is not operating, could the respiratory problems be caused by any other contamination on the PGA North site?***

Many Goodyear residents in the survey complained of respiratory problems. This included problems with asthma, hayfever, and other bronchial irritations. Many residents believe that their respiratory problems are due to the contamination on the PGA North site. However, due to the type and nature of the contaminants present at the PGA North site, it is extremely unlikely that they would cause these types of respiratory complaints reported by the community. There are several other environmental problems present in the Goodyear area that could cause these types of respiratory complaints. In fact, respiratory problems are found throughout the Phoenix Valley.

Residents also reported that a strange smell occurs in the area at night periodically. When this occurs, they and their children develop breathing difficulties which prevents them from going outside in the evenings. The nearby aluminum smelter, IMSAMET, was often identified as the source of the odors.

IMSAMET Aluminum Smelter

Many community residents are concerned about the emissions from the IMSAMET facility (formerly known as Imsalco). The aluminum recycling plant is located at 3829 South Estrella Parkway, near the southwest corner of Goodyear Airport. This facility is not part of the PGA Superfund Site, however, ADHS investigated these concerns.

IMSAMET of Arizona was first built to burn old airplane parts after WW II. It is now an aluminum smelter facility that recycles aluminum. Aluminum dross (impure aluminum) is brought to the site from both primary and secondary aluminum industries, and then crushed and milled to produce purified aluminum ingots. The ingots are then shipped out to industries such as auto makers, aluminum siding makers and roofing companies that use the recycled aluminum in their products. Four tons of recycled aluminum is shipped out every month to such industries.

The IMSAMET facility was investigated in 1989 in response to a series of complaints by local citizens about excessive emissions (white smoke and odors). As a result, the facility was issued 29 citations in 1989 by Maricopa County for operating in violation of County Visible Emissions Standards at night. During this investigation, “the white horizontal smoke plume appeared well over 1/4 mile from the source with no end in sight.” Odors from the emissions produced were similar to a strong ammonia smell combined with a pungent onion odor (Maricopa County Memos 1990). IMSAMET installed a new baghouse to control the particulate emissions from the furnaces, and continued to educate their employees on proper operating procedures for the furnaces.

The type of industrial process conducted at IMSAMET will release smoke, odor, and particulates (small particles) into the air. According to Maricopa County, Level II source testing is conducted periodically by IMSAMET for criteria pollutants which include carbon monoxide (CO), nitrogen oxides (NOx), and particulate matter (small particles in the air). Since 1995, Level II source testing for criteria pollutants conducted by IMSAMET has indicated that the facility is in compliance according to the permit conditions listed by Maricopa County, with the exception of a test conducted in 1999. This test showed elevated levels of CO and the results are being verified. Maricopa County staff also visited the facility in response to the ADHS inquiry but stated that nothing could be identified as the cause of the odors. ADHS encouraged Maricopa County to continue its investigation especially at night.

Community residents continue to complain of intermittent white smoke at night which they believe causes their respiratory problems. Even though the levels of particulates in the emissions are within acceptable limits, the inhalation of particulates may cause respiratory irritation, aggravate mucous membranes, and create discomfort in those people already prone to respiratory disease (Maricopa County memos, 1990). Testing for specific substances such as lead, beryllium, cadmium, or dioxins have not been conducted. Community residents are encouraged to call the Maricopa County Environmental Response and Complaint line at 602/506-6616 if they would like to find out more about the IMSAMET facility, discuss their concerns, or find out more about its compliance history. IMSAMET will also offer tours of their facility for interested residents.

Dust and Particulate Matter

Additional air quality issues exist in the Goodyear area that could explain some of the respiratory problems that are affecting so many community residents. There are high levels of dust and particulate matter in the air that come from farming activities and pesticide spraying. These

types of activities are known to cause respiratory problems but are oftentimes overlooked since much of the community focus is on the contamination at the PGA North site. The contamination at the PGA North site does not have the necessary environmental characteristics that normally cause such health problems throughout a surrounding community. This is described below in more detail.

Maricopa County has been in violation of the standards for small air particles (particulate matter less than 10 microns in size, called "PM-10") for most of the past decade. Particulate matter consists of airborne particles made of solid and liquid droplets of materials that vary in size and origin. The small particles can be inhaled into the respiratory tract causing respiratory problems. The smallest of these particles (less than 2.5 microns in size) are thought to be the most damaging since they can be breathed deeply into the lungs causing severe irritation.

The causal link between exposure to small particulate matter and adverse health effects is well established. While some people are not affected by this type of air pollution, others will be very sensitive and develop certain types of bronchial irritations including asthma, and hayfever. The estimated number of premature deaths due to PM-10 in Arizona is 963 per year. Those affected are primarily the elderly and those already suffering from a cardiopulmonary or respiratory disorders (ADHS, 1995). Particulate matter, including the smaller dust particles, can also carry certain allergens, or even viruses that may cause respiratory irritation.

According to the American Lung Association of Arizona (ALAA), respiratory problems are now extremely prevalent throughout Maricopa County. The growth of Phoenix has led to a tremendous amount of construction and farming activities which have increased particulates and dust in the air, pollens and molds, and other respiratory irritants throughout the Valley and the outlying areas (AALA 1999). Also, new pollens and molds have been introduced into the area as people have moved into the Phoenix Valley and planted different types of trees and shrubs.

Pesticides in the Goodyear area

The Goodyear area is a large agricultural area with a climate that allows farmers to grow crops all year round which includes aerial spraying of pesticides throughout the year. There have been several reports by community residents that pesticide spraying occurs on the fields and also over cars driving on the roads. While many residents may not be reactive to this type of spraying, others may be very sensitive and develop certain health problems from being exposed to the aerial drift of pesticides. Residents who believe that they have experienced this type of exposure should contact medical doctors who are familiar with pesticide poisoning and discuss their individual situations.

☐ *Is it safe to live in Goodyear since there is contamination on the PGA North site?*

Currently, community residents are not being exposed to chemicals on the PGA North site at levels that would be considered a public health hazard. The only possible exposures that

residents may have to any chemicals related to the PGA North site is to the water in the small irrigation canals located on the north end of the groundwater plume, and typical exposure scenarios indicate this does not pose a public health hazard.

5.3.2 Former Unidynamics Workers Concerns

This section identifies and addresses the concerns that were expressed by many of the former Unidynamics workers.

- ❑ ***One of the main concerns of the former Unidynamics workers is whether their current health problems are caused by past exposure to TCE and various other chemicals while working at Unidynamics. This question addresses only noncancerous health effects. The next question addresses TCE and cancer.***

As a defense contractor, Unidynamics was responsible for the design, development, production, testing, and support of tactical and strategic weapon and defense systems. A variety of chemicals such as nitric acid, hydrochloric acid, tear gas, explosive powders, paints, glue, oils, acetone, and other chemicals were used in this industry.

It is known from our preliminary overview that many former Unidynamics workers were exposed to TCE and other chemicals in their jobs on a daily basis. Their reports indicate that they were exposed to many different chemicals including nitric acid, tear gas, MEK, hydrochloric acid, explosive chemicals, radioactive materials such as tritium and cobalt, and TCE while performing different types of jobs. Many former Unidynamics workers reported that they were not adequately told of the dangers of the chemicals with which they were working and safety precautions were not always enforced.

During the survey, former employees described the type of work they did, and how they worked with the various chemicals. The workers responsible for cleaning metal parts did so by dipping them in large open vats of TCE with their bare hands up to their elbows on a daily basis. This would be an indication of direct dermal and inhalation exposures to TCE. Other employees packed hand grenades with powder, or tested tear gas components. The smoke from these tests would fill the building and everyone in the building would breathe the fumes. Reports indicated that employees continuously smelled fumes throughout the work day. Ventilation was not effective in getting rid of the chemical fumes from the daily chemical processes in the buildings. Employees stated that oftentimes these activities were conducted without proper protective equipment. While shoes, shop coats, and safety glasses were sometimes used, gloves or masks were not used regularly when working directly with the chemicals. These reports indicate that inhalation and dermal exposures occurred on a daily basis.

A separate building was used for making radioactive components for defense purposes. It is possible that employees were exposed to the radioactive materials. Without proper data, ADHS cannot determine the type of materials that were used or how they were handled.

Employees were responsible for the waste disposal of chemicals, including the radioactive waste, into dry wells located in the back of the facility. In 1980 and 1984, radioactive waste in the dumping area outside was cleaned up and taken to a proper radioactive waste facility. Chemical wastes were also taken to an area many miles west of Goodyear known as White Tanks where they were dumped, burned, and exploded. This aspect of the dumping is not covered in this report and can be addressed when additional data becomes available.

The employees that worked with the explosive powders described that they would go home covered in a pink chemical powder from the plant. This powder would then be spread in the carpet, clothes, towels, and curtains in their homes where their children would play with it. The powder would not wash out of their clothes, hair or skin. It would even get in the food in the kitchen. Although there was some concern about this voiced by the former workers, they stated that no one really understood the danger of children playing with the powder at that time and it was considered a normal occurrence. This situation would indicate direct dermal, inhalation, and possibly ingestion exposures to the pink powder, however ADHS does not know the chemical makeup of the powder.

A majority of the workers who called ADHS believed that their current health problems were caused from their past exposure to the chemicals used at Unidynamics. The major complaints reported by former workers included skin cancer, respiratory, heart, nerve, and eye problems. There were reports of various cancers such as male breast cancer, skin cancer and multiple melanoma, lung, throat and rectal cancers, leukemia, non-hodgkin's disease. Other health problems included vertigo, memory loss, facial swelling, skin problems, throat and esophagus problems, and headaches. It is very difficult to determine if these conditions are caused by previous exposures to the chemicals used at the Unidynamics plant since the exposures happened in the past and direct causation cannot be proven. While some of the symptoms that have been described by former employees are consistent with chemical exposures, there are many confounding factors that interfere with the determination of cause and effect in such a situation.

The use of radioactive materials at the former Unidynamics facility has been documented. However, ADHS was unable to obtain data to determine types of materials, and how they were used. This would help to determine what exposures to the radioactive materials may have occurred to the former workers. ADHS will conduct an investigation if future information becomes available on the type and amount of radioactive materials that were used at the facility.

It is beyond the scope of this general health assessment to conduct an epidemiological study of the health effects from past occupational exposures in this situation. However, since TCE is the chemical of concern that has been the focus of the remediation activities, the following paragraphs provide some description of health effects from occupational exposures to TCE. This will provide an indication of the types of health effects that have been suggested in studies conducted on chemical exposures to TCE in occupational settings.

A summary of animal and human studies that have been conducted on TCE can be found in the *ATSDR Toxicological Profile for TCE* (ATSDR 1997). The toxicological profiles are prepared in accordance with guidelines developed by the ATSDR and USEPA. They succinctly characterize the toxicologic and adverse health effects information for hazardous substances. Each peer-reviewed profile identifies and reviews the key literature that describes a hazardous substance's toxicologic properties.

Respiratory problems were the most noted Unidynamics worker health symptom. Although this type of health problem has many causes, it is possible that past exposures to chemicals used at Unidynamics may have caused respiratory problems for some of the former workers. In fact, one former worker stated that their doctor had requested that they change their job because the chemical exposures at work had compromised their esophagus and respiratory system. Morphology of lung cells has been studied in rats and mice exposed to TCE. A 30-minute inhalation exposure to 500 parts per million (ppm) resulted in changes in the nonciliated epithelial cilia of the bronchial tree. Similar Clara cell-specific damage was observed in mice after a 6-hour exposure to 100 ppm TCE. A reduction in pulmonary enzyme activity was also observed. In an occupational study, a worker developed labored breathing and respiratory edema after welding stainless steel that had been washed in TCE. This was attributed to inhalation of the decomposition products of TCE. However, he also had a history of smoking which may have predisposed the subject to these respiratory effects (ATSDR 1997, p. 12).

Another common health complaint described by former workers were heart problems. Cardiac effects including tachycardia, ECG abnormalities, and arrhythmias have been reported in humans following acute inhalation exposures to TCE. A number of deaths following acute inhalation exposure to TCE have been attributed to cardiac effects (ATSDR 1997, p. 167). A few case studies of persons who died following acute occupational exposure to TCE have revealed cardiac arrhythmias to be the apparent cause of death. In animals, TCE is apparently responsible for the cardiac sensitization because chemicals that inhibit the metabolism of TCE increase its potency. In one study, hypertension, enlarged heart, and arrhythmia were seen in some workers accidentally exposed to TCE at a level that was unspecified but at least 15 ppm. Sufficient human and animal information is available to identify the nervous system as the most sensitive target for the acute effects of TCE from inhalation.

Information from occupational studies on humans indicated that, while the nervous system may be the most sensitive target of TCE exposure, other targets include the liver and kidneys. Short term exposures showed that working with TCE and its breakdown products have led to residual neuropathy, characterized by nerve damage particularly characterized by facial numbness, jaw weakness, and facial discomfort (ATSDR 1997, p. 27). Other reported neurological effects of chronic occupational exposure to unquantified TCE levels include memory loss, mood swings, trigeminal neuropathy, cranial nerve VII damage and decreased psychomotor function, impaired acoustic-motor function, and psychotic behavior with impaired cognitive function. A case study of a retired metal degreaser who had been exposed to between 1.5 and 32 ppm for 1-2 hours per day over a period of 20 years reported symptoms of headache, forgetfulness, vertigo, nausea, and

loss of feeling in hands and feet persisting for 4 years after retirement (ATSDR 1997, p. 38). Other symptoms of workers exposed to chronic long term exposures to TCE (between eight and 170 milligrams per cubic meter (mg/m^3)) for one to two hours per day over a period of 20 years reported symptoms of headaches, forgetfulness, vertigo, nausea, and loss of feeling in hands and feet (ATSDR 1997, p. 171). Human experimental studies revealed mild effects on motor coordination, visual perception, and cognition (ATSDR 1997, p. 138). The symptoms noted above were reported by some of the former Unidynamics workers in the community survey.

A TCE registry has been established by ATSDR to monitor people in communities where exposure could be verified and doses could be adequately estimated. The participants are interviewed regularly to collect important health data over their lifetimes to provide more understanding of the effects of exposure to TCE. Thus far, data indicate excess numbers of heart disease and respiratory cancer deaths, as well as stroke, anemia, liver and kidney disease, and hearing and speech impairment. The greatest limitation to these studies is the difficulty in estimating dose, and possible exposure to multiple chemicals (ATSDR 1997, p.170).

The development of adverse health effects from exposure to TCE is “dose” and “situation” dependent. According to the ATSDR Toxicological Profile for TCE, a susceptible population will exhibit a different or enhanced response to TCE than will most persons exposed to the same level of TCE in the environment. Reasons may include genetic makeup, age, health and nutritional status, and exposure to other toxic substances such as cigarette smoke. These factors may result in a reduced detoxification or excretion of TCE, compromising the function of organs affected by TCE. In addition, people who consume alcohol or are treated with disulfiram may be at greater risk of TCE poisoning because ethanol can inhibit the metabolism of TCE and cause it to accumulate in the bloodstream, increasing its potential effects on the nervous system. Compromised hepatic and renal function may place one at higher risk upon exposures to TCE or its metabolites since the liver serves as the primary site of TCE metabolism and the kidney as the major excretory organ for TCE metabolites. Metabolism of TCE differs significantly between men and women (ATSDR 1997, p. 161).

Although many of the self-reported symptoms reported by workers appear to be consistent with TCE exposures, the cause for such symptoms cannot be fully determined by this health survey. An in-depth study would be required to determine if an association between past exposures to TCE and present health problems could be identified. Since the exposures occurred in the past, and since there are many factors that would interfere with the analysis, such a study would have many limitations preventing a solid conclusion. In other words, based on the available data, there is no way to determine if a worker’s past exposure to the chemicals used at Unidynamics is the definite cause of their current health problems. Former workers, who are concerned about their exposures to the chemicals at the plant, are encouraged to speak with a doctor who is trained in occupational exposures and to discuss their health status and previous exposures to chemicals for a more specific individual exposure assessment.

A summary that provides a description of additional studies conducted on occupational exposures to TCE and their results is provided in the Appendix, and also in the *1997ATSDR Toxicological Profile for TCE*.

❑ *Does exposure to TCE cause cancer?*

According to the *ATSDR Toxicological Profile for TCE*, tumors in the lungs, liver, and testes were found in studies using high doses of TCE in rats and mice, providing evidence that high doses of TCE can cause cancer in experimental animals. Based on the limited data in humans regarding TCE exposure and cancer, and evidence that high doses of TCE can cause cancer in animals, the International Agency for Research on Cancer (IARC) has determined that TCE is probably carcinogenic to humans. In general, the associations drawn from the limited epidemiological data in humans, as well as cancer studies in animals, are suggestive yet inconclusive. Based on the available data, cancer should be an effect of concern for people exposed to TCE in the environment and at hazardous waste sites (ATSDR 1997, p.5, 153). In general, people with the greatest potential for exposure to TCE are those exposed in the workplace. Health effects from these exposures depend on many factors including sex, age, type and length of exposures to TCE, and concentrations of TCE.

Three European studies have found slight but statistically significant increases in cancer in workers exposed to TCE. One such study showed that the combined incidence of stomach, liver, prostate, and lymphohematopoietic cancers was increased among 2,050 male and 1,924 female Finnish workers who were occupationally exposed primarily to TCE and other solvents. The workers were exposed principally through inhalation, although there was some dermal contact. In a study of Swedish workers who worked with TCE, a statistically significant increase in non-hodgkin's lymphoma was observed. However, these studies are limited by uncertainties in the exposure data, small sample sizes, and likely exposure to other chemicals (ATSDR 1997, p. 46, 96).

The ADHS survey showed that among the workers, skin cancer including melanoma was the most prevalent cancer. This was followed with cases of lung cancer, non-hodgkin's lymphoma, male breast cancer, and throat cancer. Other epidemiologic studies have examined the effect on workers from inhalation exposure to TCE. A significant increase in bladder cancer and lymphomas was detected in a cohort of 1,424 men with unspecified exposure to TCE. In another study, a significant rise was also discovered in the incidence of lung/bronchus/trachea, cervix, and skin cancers in more than 330 deceased cleaning and/or laundry workers who worked with TCE.

❑ *Does exposure to TCE cause Lupus?*

It is not known whether exposure to TCE can cause lupus. Systemic lupus erythematosus (SLE), commonly called lupus, is a chronic multisystem inflammatory disorder. The exact cause of lupus is unknown. In lupus, the body produces abnormal antibodies that react against the person's

own tissues. Lupus can affect many organs of the body including the heart, lungs, kidneys, and central nervous system. The disease can look like many different illnesses; it may cause some rashes, arthritis, anemia, seizures, or psychiatric illness (American College 1992).

SLE is four times more common in African Americans compared with Caucasians in the United States. Hispanics and Asians have been reported to have higher rates than Caucasians. An elevated prevalence of SLE has been found in North American Indians. However, this increased prevalence was isolated to three of 75 American Indian tribes. A prevalence rate of 119 per 100,000 persons was reported in Sioux women (Fessel 1988).

☐ *Are learning disabilities and mental retardation caused by exposure to TCE?*

According to the *ATSDR Toxicological Profile for TCE*, learning disabilities and mental retardation have not been associated with chronic exposure to TCE in the drinking water.

☐ *Several former workers stated that they had contacted the Occupational Safety and Health Administration (OSHA) on several occasions and wanted to know if those investigations were on file.*

Several former workers told stories of workers getting injured or killed in explosions, having severe breathing and eye problems from the chemical fumes in the plant, and dipping their arms in large TCE vats to wash metal parts without the use of gloves or eye protection. According to some reports, safety precautions were not enforced or encouraged. There were descriptions of workers who, after working with a toxic pink powder all day at work, would go home covered in the powder which would then get into the carpets, drapes, towels, clothes, and hair of their children and would not wash out.

Some former workers stated that they contacted the Occupational Safety and Health administration (OSHA) on several occasions about the poor working conditions at the plant but for political reasons, they were not allowed to speak with OSHA representatives alone without their supervisors. They felt that this prevented OSHA from knowing about the poor safety conditions at the plant allowing for the continuation of more injuries on the job. Other workers stated they were afraid to say anything because they would lose their jobs.

OSHA has one investigation on record that was conducted in 1989. They found poor electrical set ups in the plant that were subsequently fixed. By law, OSHA is only able to address current existing problems at work sites. The OSHA is unable to currently address past occupational complaints of former Unidynamics workers particularly since the Unidynamics plant is now closed. According to the OSHA, a complaint can be filed with them anonymously and it will be followed up especially if more than two people call in. The OSHA tries to provide anonymity for employees who file a complaint by keeping their names, positions, and other employee identifying information unknown to the employer in question (OSHA 1999). The federal OSHA has a web site that reports the investigations that have been conducted at occupational facilities

around the country.

5.4 ATSDR's Child Health Initiative

ATSDR's Child Health Initiative recognizes that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination of their water, soil, air, or food. Children are at greater risk than adults from certain kinds of exposures to hazardous substances emitted from waste sites and emergency events. They are more likely to be exposed because they play outdoors, they often bring food into contaminated areas, and the developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. HBGLs used in this report are specifically protective of childhood exposure for adverse health effects.

There are four major issues that relate to children living near the PGA North site. They are as follows:

- ☐ The level of the TCE and perchlorate in the water in the small irrigation canals is low enough that even if children play in it during the day, adverse health effects would not be expected.
- ☐ The water in the holding pond has not been tested for TCE and perchlorate. Since it appears that the water from the small canals flow into the holding pond, it would be prudent to have the water tested. Trash around the holding pond and a chair indicates that children play around this area.
- ☐ There are many physical hazards at the PGA North site along the smaller irrigation canals and the holding pond area. These include rusty broken metal pipes, large broken ragged cement pipes that children can crawl into, a large unprotected open well which a child could fall into, rusty piping around the Globe wells, rusted metal laying on the ground, and other physical hazards that could hurt children playing in the area. In addition, the underlying canal tunnels are completely open when the canals are dry. These tunnels leave areas where children could fall into and get hurt. Photographs that show some of the physical hazards in the area are included in the Appendix.
- ☐ There were several reports of children having respiratory problems in the Goodyear area. As stated previously, the nature of the contamination on the PGA North site is such that it does not explain all the respiratory complaints. Various causes for these have been explained in this document. Residents are encouraged to contact the Air Quality Division at the Maricopa County Environmental Services Department or the Arizona Department of Environmental Quality (ADEQ) to find out detailed specific information regarding air quality in the West Valley, or to file complaints. Health questions related to air pollution in the area can be addressed at the ADHS, Office of Environmental Health.

In summary, there are many physical hazards in and around the irrigation canals that could pose a health threat to children who might play in the area. Since new housing developments are being built near these irrigation canal areas, it is important to secure these areas in such a way to prevent children from gaining access and getting hurt.

6.0 Conclusions

*The Arizona Department of Health Services (ADHS) concludes that **no apparent public health hazard** exists as a result of ingestion, dermal, or inhalation exposures by residents to the contaminated groundwater at the Phoenix Goodyear Airport (PGA) North site given the current data. However, potential future exposure to the groundwater contamination could present an **indeterminate health hazard** if the levels of trichloroethylene (TCE) and/or perchlorate in the small irrigation canals on the north end of the plume, or in the irrigation well at Park Shadows Apartments rises above their respective screening levels. Because of safety concerns, the Globe Wells and the irrigation canals that are connected present a **public safety hazard to children** who might play in the area. Historic occupational exposure to chemicals at the Unidynamics plant presented an **indeterminate health hazard** to workers due to insufficient exposure data.*

This public health assessment concludes the following:

1. Public drinking water supply wells in the Goodyear, Litchfield, and Pebble Creek areas present no public health hazard.
2. Globe Wells # 1 and #2, and the Park Shadows Apartments irrigation well have been found to contain levels of TCE above the United States Environmental Protection Agency's (USEPA) maximum contaminant level (MCL) of 5 micrograms per liter (µg/L). However, quantitative analysis shows the level of TCE is one that not would be expected to cause adverse health effects for residents through inhalation, ingestion, or dermal exposures. Globe Well #2 has also been found to have traces of perchlorate. The level of perchlorate is not above ADHS's health-based guidance level (HBGL) and would not be expected to cause adverse health effects if children play or drink the water or if farmworkers use it to rinse off or drink during the day. The water from these wells poses no apparent public health hazard
3. The physical hazards posed by the Globe wells and canals present a public safety hazard to children who may play in the area. There are many physical hazards along the smaller irrigation canals connected to the Globe Wells and the holding pond area. These include rusty broken metal pipes, large broken ragged cement pipes that children can crawl into, a large unprotected open well which a child could fall into, rusty piping around the Globe wells, rusted metal laying on the ground, dangerous electrical outlets, and other physical

hazards that could hurt children playing in the area. When the water is not flowing through the canals, the underlying tunnels are left open and leave an area where children could fall into and get hurt.

4. The water from the SunCor Well #33A, which is connected to a carbon filter treatment system, is being used for irrigation of the golf courses and ornamental lakes in the Pebble Creek housing development and for the new SunCor housing development. The treated level of TCE poses no apparent public health hazard.
5. No TCE has been detected in the drinking water well at Park Shadows Apartments. The level of TCE in the irrigation well is below the MCL. These wells pose no apparent public health hazard.
6. Many Goodyear residents are concerned about living near the Unidynamics facility (part of the PGA North site). The on-site soil contamination presents no public health hazard. The on-site thermal oxidizer has been turned off eliminating any potential exposures to emissions. There are not enough data and information to determine if, or how much, dioxin was in the thermal oxidizer emissions when it was operating. However, TCE testing was conducted in the past air emissions. Using the maximum TCE concentrations detected in these past air emissions, modeling data indicate that the TCE concentrations in ambient air posed no public health hazard.
7. Historic occupational exposure to chemicals at the Unidynamics plant presented an indeterminate health hazard to workers. Former Unidynamics workers have voiced concerns about health problems that have developed subsequent to their employment at the plant. Some of the health problems expressed by former workers, such as respiratory, heart, nerve, and eye problems, are consistent with long term exposure to working with high levels of TCE. However, the cause for these health problems cannot be directly linked to their past exposures to chemicals at the plant since there are many confounding factors.
8. The most common health complaints expressed by both the community residents and former workers are respiratory problems including asthma. Respiratory problems of community residents are consistent with living in a very active agricultural and farming area such as Goodyear. As in any farming community, this type of activity causes dust, particulate matter, and pesticides to get into the air which can cause breathing problems for community residents who live nearby.
9. Many community residents are concerned about the emissions from the IMSAMET facility, the aluminum recycling plant on the southwest corner of the Goodyear Airport. This facility is not part of the PGA Superfund Site. However, ADHS investigated these complaints in response to community concerns during the PGA North site survey. The type of industrial process conducted at IMSAMET releases smoke, odor, and particulates

into the air. Even if the levels of particulates are within permitted limits, the inhalation of particulates may cause respiratory irritation, aggravate mucous membranes, and create discomfort in those people already prone to respiratory disease.

10. ADHS conducted three epidemiological studies that reviewed mortality and incidence data in Maricopa County including the Goodyear area. The data in these studies indicated that there have not been elevated mortality or incidence rates of total cancers or leukemia in the Goodyear area from 1965 through 1990.

7.0 Recommendations

The Arizona Department of Health Services (ADHS) makes the following recommendations based on its investigation of the Phoenix Goodyear Airport (PGA) North site:

1. Sample and monitor the water from the Globe wells and the Park Shadows Apartments irrigation well on a regular basis to ensure that the levels of trichloroethylene (TCE) do not exceed 87 micrograms per liter ($\mu\text{g/L}$) and the levels of perchlorate do not exceed 14 $\mu\text{g/L}$. If the levels do exceed these health-based screening levels, then actions should be taken to prevent children and adults from coming in contact with the water.
2. Repair and post a warning sign on the Globe well #2.
3. Post additional signs along the irrigation canals warning children not to drink the contaminated water or play in or near the canals. These signs should be written in both English and Spanish and posted in an area where children will be able to see them.
4. Restrict access (e.g., fencing) to the Globe wells to prevent children from playing near them.
5. Cover the openings (e.g., fencing) to the tunnels of the irrigation canals to prevent children from crawling into them when the canals are dry.
6. Post signs, in both English and Spanish, near the holding pond that indicate that physical hazards exist to children who may play in this area and that the water in the holding pond is potentially contaminated with TCE and perchlorate.
7. Sample the water in the holding pond for TCE and perchlorate to determine the levels of contaminants present.
8. Restrict access (e.g., fencing) to the pumps on both ends of the holding pond to prevent children from gaining access to the physical hazards (e.g., rusted broken metal and cement pipes and dangerous electrical outlets) present in these areas.
9. Remove the canisters of liquid that are on the pumps to prevent any children from playing with or drinking the liquid.
10. Inform all prospective home buyers (e.g., Pebble Creek and SunCor housing developments) with full disclosure that the water in the irrigation canals is contaminated and that the canals present a physical hazard to children who might play in and around them. Residents should be informed that the contaminated water being used for irrigating the nearby golf courses and the ornamental lakes area is coming from a treated well and does not pose a current health hazard.

11. Sample and monitor the effluent water from the SunCor Well 33-A for TCE and perchlorate on a regular basis to ensure the carbon filter treatment system is working properly and consistently.
12. Sample and monitor the private wells (one drinking well and one irrigation well) at the Park Shadows Apartments for TCE and perchlorate on a regular basis to ensure that the levels remain safe. Letters should be sent to residents of the apartments on a yearly basis showing the sampling results. Results of the sampling should also be posted on the bulletin board at the Park Shadows Apartments. ADHS strongly suggests that the irrigation well not be converted into a drinking well.
12. Conduct health education activities for new residents who will be moving into the new housing developments (e.g., Pebble Creek and SunCor) near the PGA North site. Activities would include a summary of the public health assessment and its recommendations, current and future activities by environmental agencies like USEPA and ADEQ, and updates on the remediation activities at the site.
13. Conduct a more in-depth investigation of the contamination at the White Tanks dumping area to assure that all contamination has been identified and appropriately remediated if necessary. ADHS will review new data to determine if a health consultation is needed for this site.
14. Former Unidynamics workers who are concerned about any chemical exposures in their current work environment are encouraged to call the Occupational Safety and Health Administration. All information is kept confidential.
15. Encourage former Unidynamics workers who have concerns about their past exposures to the chemicals used at the Unidynamics to discuss these concerns with a doctor who is educated in occupational exposures.

8.0 Public Health Action Plan

The Public Health Action Plan (PHAP) for the Phoenix Goodyear Airport (PGA) North site contains a description of actions taken, to be taken, or under consideration by the Agency for Toxic Substances and Disease Registry (ATSDR) and the Arizona Department of Health Services (ADHS) at and near the site. The purpose of the PHAP is to ensure that this public health assessment not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. ADHS and ATSDR will follow-up on this plan to ensure that actions are carried out.

Actions Completed

1. In February 1999, ADHS attended a public meeting held by United States Environmental Protection Agency (USEPA) to announce the public health assessment. Questionnaires were handed out to people who attended the meeting to identify what their concerns were.
2. In May 1999, ADHS and ATSDR staff met with the Crane Company (Crane Co.) to discuss the scope of the public health assessment and to address their concerns and questions.
3. In July 1999, ADHS staff met with regulatory agencies such as USEPA, and Arizona Department of Environmental Quality (ADEQ) to review and determine the status of the current data on the contaminants at the PGA North site.
4. During the summer of 1999, ADHS met with consulting companies Malcolm Pirnie and ASL Hydrologic on various occasions to review additional data, and discuss plans for further remediation activities at the PGA North site.
5. USEPA, ADEQ, Malcolm Pirnie, and the Crane Co. have been involved in the remedial actions over the past 10 years to address contaminants in soil and groundwater at the PGA North site. These activities are ongoing and include groundwater treatment and soil remediation.
6. ADHS mailed press releases to area newspapers to announce the public health assessment activities and to advise residents using private wells in the area to call and talk with ADHS staff. Several callers from the area responded who were then referred to ADEQ to have their wells sampled.
7. During the summer of 1999, ADHS conducted six PGA North site visits to identify any potential exposure pathways to contaminants in the groundwater, investigate some of the concerns expressed by residents in the area, and to take photographs.

8. From May 1999 through August 1999, ADHS conducted a community survey over four months to identify and address concerns of the residents and former Unidynamics workers. This included several radio, newspaper, and television interviews which described the PGA North site and the public health assessment and asked people to express their concerns related to the site.
9. In response to the community survey, ADHS sampled a private well. Other residents who wanted private wells sampled were referred to ADEQ.
10. ADHS mailed more than 60 packets to community members that included environmental health information related to the site. These included original fact sheets that explained exposure pathways, public health assessments, and facts on TCE and perchlorate. USEPA fact sheets were also included in the mail out that provided background information on the site.
11. ADHS mailed 20 packets to area doctors to inform them of the public health assessment activities. Included in these packets were original fact sheets on diagnosis and treatment of TCE and perchlorate exposures, ATSDR information on the TCE registry, and USEPA fact sheets that provided background information on the site.
12. ADHS collaborated with the Arizona State University (ASU) to begin an environmental health internship program to train interested students. In June 1999, an intern was hired to assist with the PGA North site public health assessment. The intern was trained in the various aspects of conducting a public health assessment and given responsibility to prepare various sections in the public health assessment, respond to community concerns, research and summarize data, and identify and discuss exposure pathways at the site.
13. ADHS staff conducted a survey with more than 60 community members on a one-to-one basis to identify concerns. The survey helped ADHS understand the concerns of the residents living near the site and the former Unidynamics workers. This made it possible for ADHS staff to write a public health assessment that would be beneficial and educational to community residents and former workers.
14. ADHS prepared a public health assessment that was designed to address the concerns of the community residents and former Unidynamics workers. It was decided that the best way to clarify the any misunderstandings, confusion, and fears expressed by callers was to identify and answer the major questions posed by residents who called in. This would make the public health assessment an educational tool that would be available for future reference.

Actions Proposed

1. ADHS plans to meet with the community residents and former Unidynamics workers at a public meeting to communicate the findings of the PGA North site public health assessment. The goals of the meeting are to increase the understanding of the technical aspects of the area contaminants and their fate and transport, and to educate the community on ways to minimize their exposures to site-related contaminants and physical hazards.
2. USEPA, ADEQ, and the Crane Co. should continue to reduce the site-related contamination to levels that meet regulatory requirements.
3. The City of Goodyear, Litchfield, and SunCor will continue to monitor municipal wells in the area to ensure that all drinking water remains safe.
4. ADEQ will continue to monitor the private wells (one drinking well and one irrigation well) at Park Shadows Apartments on a regular basis to ensure they remain safe.
5. ADHS will work with USEPA and ADEQ to see that the physical hazards posed by the area (irrigation canals and holding pond area) are made safe for children.
6. To protect human health, the Crane Co. will continue to monitor the Globe wells, particularly Globe Well #2 to see that the levels of TCE and perchlorate do not increase above safe levels described in this public health assessment.
7. ADHS will continue to address community concerns as residents or former workers request assistance.

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APPENDIX

1. Map showing location of the PGA North site.
2. Map showing the location of the Unidynamics plant and contaminated groundwater plume.
3. Photographs of the PGA North site.
4. Exposure history forms.
5. Toxicological profile for TCE.
6. Graph displaying various sources of dioxins and furans.
7. Summary of target analytes in Globe and SunCor wells.
8. Calculations for exposure doses.
9. Definitions of ATSDR Hazard Categories

Table A30

Calculation of Estimated TCE concentrations in air from Thermal Oxidizer Emissions

Estimation of outdoor air concentrations (OAC) of trichloroethylene (TCE) from past thermal oxidizer emissions in milligrams per cubic meter (mg/m³):

$$\text{OAC} = E / [(w)(h)(u)]$$

Assumptions : Area of emission (A_e) = 100 square meters (m²)
Average annual wind speed in Phoenix = 2.6 meters per second (m/sec)
Highest TCE concentration in emissions data = 59 micrograms per liter (µg/L)
Continual residential exposure to emissions

Where:

E	=	emission rate into box (0.007 m ³ /sec)(59 mg/m ³)	= 0.413 mg/sec
		in milligrams per second (mg/sec)	
w	=	square root area of box in meters (m)	= 10 m
h	=	height of box in meters (m)	= 10 m
u	=	wind velocity	= 2.6 m/sec

OAC	=	Outdoor air concentration of TCE	= 0.0016 mg/m³
ADHS annual air HBGL for TCE			= 0.009 mg/m³

ATSDR HAZARD CATEGORIES

The ATSDR has designated 5 separate health hazard categories to identify the type and severity of the site-specific hazards identified in the health assessment. The categories are chosen based on the available site-specific data and conclusions of the health assessment. Recommendations and health advisories are made according to the assigned categories.

Category A: Urgent Public Health Hazard

This category is used for sites where short-term exposures (<1 yr) to hazardous substances or conditions could result in adverse health effects that require rapid intervention.

Criteria:

Evaluation of available information indicates that site-specific conditions or likely exposures have had, are having, or are likely to have in the future, an adverse impact on human health that requires immediate action or intervention. Such site-specific conditions or exposures may include the presence of serious physical or safety hazards, such as open mine shafts, poorly stored or maintained flammable/explosive substances, or medical devices which, upon rupture, could release radioactive materials.

Actions:

ATSDR will expeditiously issue a health advisory that includes recommendations to mitigate the health risks posed by a site. The recommendations issued in the health advisory and/or health assessment should be consistent with the degree of hazard and temporal concerns posed by exposures to hazardous substances at a site.

Category B: Public Health Hazard

This category is used for sites that pose a public health hazard due to the existence of long-term exposures (>1 yr) to hazardous substances or conditions that could result in adverse health effects.

Criteria:

Evaluation of available relevant information suggests that, under site-specific conditions of exposure, long-term exposures to site-specific contaminants (including radio nuclides) have had, are having, or are likely to have in the future, an adverse impact on human health that requires one or more public health interventions. Such site-specific exposures may include the presence of serious physical hazards, such as open mine shafts, poorly stored or maintained flammable/explosive substances, or medical devices which, upon rupture, could release radioactive materials.

Actions:

ATSDR will make recommendations in the health assessment to mitigate the health risks posed by the site. The recommendations issued in the health assessment should be consistent with the degree of hazard and temporal concerns posed by exposures to hazardous substances at the site.

Category C: Indeterminate Public Health Hazard

This category is used for sites when a professional judgement on the level of health hazard cannot be made because information critical to such a decision is lacking.

Criteria:

This category is used for sites in which “critical” data are insufficient with regard to extent of exposure and/or toxicologic properties at estimated exposure levels. The health assessor must determine, using professional judgement, the “criticality” of such data and the likelihood that the data can be obtained and will be obtained in a timely manner. Where some data are available, even limited data, the health assessor is encouraged to the extent possible to select other hazard categories and to support their decision with clear narrative that explains the limits of the data and the rationale for the decision.

Actions:

Public health actions recommended in this category will depend on the hazard potential of the site, specifically as it relates to the potential for human exposure of public health concern. If the potential for exposure is high, initial health actions aimed at determining the population with the greatest risk of exposure can be recommended.

Category D: No apparent Public Health Hazard

This category is used for sites where human exposure to contaminated media may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause any adverse health effects.

Criteria:

Evaluation of available relevant information indicates that, under site-specific conditions of exposure, exposures to site-specific contaminants in the past, present, or future are not likely to result in any adverse impact on human health.

Actions:

If appropriate, ATSDR will make recommendations for monitoring or other removal and /or remedial actions needed to ensure that humans are not exposed to significant concentrations of hazardous substances in the future.

Category E: No Public Health Hazard

This category is used for sites that, because of the absence of exposure, do NOT pose a public health hazard.

Criteria:

Sufficient evidence indicates that no human exposures to contaminated media have occurred, none are now occurring, and none are likely to occur in the future.

Actions:

No public health actions are recommended at this time because no human exposure is occurring, has occurred in the past, or is likely to occur in the future that may be of public health concern.

Appendix – Public Comments and Responses

ADHS and ATSDR provided an opportunity in the final draft stage of this document from July 10 through August 31, 2000. Three individuals responded with various comments. The comments received are summarized below along with ADHS responses to those comments.

Comment A:

A former Unidynamics worker wrote complementing EPA, ATSDR, and ADHS on the work done on this project and asked “...has the assessment gone far enough? [they] believe all former workers who were exposed to chemicals at Unidynamics should be interviewed personally....”

Response A:

ADHS appreciates the comment on the work that has been done. ADHS notes that worker health is beyond the authority of ATSDR and ADHS and that no past data were available about specific air quality conditions inside the workplace. Therefore, ADHS has no basis to conduct any further activities with former workers. As stated in Section 5.3, former workers who are concerned about their exposures to the chemicals at the plant are encouraged to see a doctor who is trained in occupational exposures.

Comment B:

A citizen wrote with several specific comments and questions on the Public Health Assessment as follows:

Comment B-1) Conclusions, p.42, #10 - With regard to the three studies and the Cancer Registry not starting operations until 1985, and cancer deaths not reported to the Cancer Registry between 1965 and 1985 and data from that registry used in the final analysis, wouldn't that affect the overall outcome of the study?

Response B-1) : There are three studies discussed in text:

- Mortality in Maricopa County, 1966 - 1986, was based on death certificates (not the cancer registry) and therefore is not affected by the comment.
- Incidence of Childhood Cancer in Maricopa County, 1965 - 1986, does consider years before there was a cancer registry (as noted in the comment), however the authors of the study indicate their methods were an extensive effort to essentially create a cancer registry database for children by gathering appropriate records from hospital files throughout the county. ADHS considers the study to be a correct methodology and finds the results useful.
- Follow-up of Childhood Leukemia Incidence Rates in Maricopa county, 1987-1990, was a study conducted entirely from the cancer registry data and so is not related to the comment.

Comment B-2) Recommendations, p.43, #10 - Regarding notification of future homebuyers of Pebble Creek and SunCor housing....How will EPA or ADEQ inform all future homebuyers that

contamination exists ? Wouldn't it be reasonable to also inform the current residents of the TCE contamination and the physical dangers to their children?

Response B-2)

ADHS concurs with the comment that it is reasonable to inform current homeowners about the contamination, but ADHS cannot provide the specific details of EPA or ADEQ planned activities. Commenter should contact either of those agencies for details. ADHS does note that the site receives significant coverage in news media (print and broadcast) and newsletters by EPA and ADEQ, all of which should provide reasonable notice to local residents..

Comment B-3) Recommendation #13, p. 44 - Make sure that the in-depth investigation of the contamination at the White Tank dumping area is carried out, new housing developments are being considered for the area.

Response B-3)

Similar to comment 2, specific notification and investigation requirements are carried out by EPA and ADEQ and commenter should contact those agencies for details of their work. ADHS understands that EPA and ADEQ are investigating potential areas of waste disposal and encourages anyone with specific information on waste material or disposal locations to contact ADEQ or EPA. ADHS will provide copies of this Public Health Assessment to EPA and ADEQ for their use in site related investigations.

Comment B-4) Comment comparing statements about lead, chromium, and Volatile Organic Compounds (VOCs) from 1989 Preliminary Public Health Assessment for Phoenix Goodyear Airport to the present document and asking about the chromium and lead cited in 1989 but not listed as hazards in current document.

Response B-4)

The 1989 Preliminary Assessment covered the initial contamination detected in the overall Goodyear airport area, current EPA work (and the current Public Health Assessment) has identified different areas of contamination and is addressing them as two separate areas: PGA-North area and PGA-South area. Chromium discussed in the 1989 document was found at Goodyear Aerospace area which is part of PGA- South area (and therefore is not an issue for the current PGA- North report). Chromium sampling was conducted in the PGA- North area and levels were not of public health concern (see Table 2 in this report).

Lead was found in soils at the Unidynamics site at levels above residential SRL's (see Table 2, this report), but it because the site is fenced and therefore no completed exposure pathway exists, the levels present do not pose any public health hazard. ADHS is aware that EPA and ADEQ are still working with those responsible for clean-up activities to see that lead levels on-site are remediated so that they pose no public health concern if the site area becomes more accessible.

Comment B-5) Recommendation #15, p. 44 - Whose responsibility is it to "encourage former

Unidynamics workers who have concerns about their past exposures to discuss these concerns with a doctor...”? According to the Summary, 31 exposure histories were taken from Unidynamics employees..... it may be appropriate for ATSDR to conduct such studies.

Response B-5)

Through public open houses, newspaper articles, and television news coverage, ADHS has provided widespread information about this site and where concerned persons can find more information. EPA and ADEQ also have undertaken many efforts, including newsletter mailings and public meetings, to provide information to all stakeholders concerned about this site. As stated previously in Response A of this appendix, it is outside the scope of ADHS’ and ATSDR’s authorized activities to conduct a study of worker health related to occupational exposures.

Comment C:

A citizen comment that incorrect information was provided in the Public Health Assessment regarding the wells at the Park Shadows. The comment stated that the Park Shadows wells are being sampled monthly (not quarterly) and that residents were provided copies of the results and the results were also posted on the community bulletin board in the Park Shadows complex.

Response:

See corrected text in final document.